BIG DAM FOOLISHNESS

"Flood control
is mainly a problem in land use.
Though it would probably be blocked
by unwieldy bureaucracy,
the logical thing would be
to put all flood control policy
under the U. S. Department of Agriculture."

AUTHOR.

BIG DAM FOOLISHNESS

The Problem of

Modern Flood Control and Water Storage

BY ELMER T. PETERSON

AUTHOR OF *Forward to the Land*

INTRODUCTION BY Paul B. Sears

NEW YORK · 1954

THE DEVIN-ADAIR COMPANY

To the Valiant People of the Valleys
Who Fight for Their Homes and Their Lives

THE DEVIN-ADAIR COMPANY,
23 EAST 26TH STREET, NEW YORK 10, N.Y.

LIBRARY OF CONGRESS CATALOG CARD NO. 54-10812

MANUFACTURED IN THE UNITED STATES OF AMERICA

CANADIAN AGENTS:
THOMAS NELSON & SONS, LTD., TORONTO

Introduction

Science, when it can be used in warfare (and this includes a surprising amount of medical knowledge), in manufacture and business, or in spectacular health measures, gets prompt attention. When its benefits are long-range, to be diffused through society by the slow process of education and self-control, the going is not so easy. The scientist can speak his piece and let the public go to hell if it chooses; or he can turn evangelist—an unhappy role for him—and try, as preachers always have, to urge good behavior in the hope of its ultimate reward.

Now and then he gets welcome help from a layman of insight, whose profession does not bar him from the rough and tumble of the forum, or better yet, one whose business it is to enlighten and inform the public. Such a man is Elmer T. Peterson, whose skill in making information palatable without distorting it is evident in the pages that follow.

A series of meticulous researches following the climatic and economic crisis of the 1930's has served to confirm an ancient intuition of the students of earth

and life. This belief—for it is scarcely emerging as a law—holds that no species, not even Man, can multiply indefinitely without having to reckon with the limitations of the environment; that all species, including Man, exist by virtue of orderly processes within the environment, regulating the flow of energy and material change; and that Man is well advised to respect and conserve these processes, rather than disrupt them.

One of the first, and most costly, results of disruption is water trouble—too much where it is not wanted, too little where it is needed. The essential picture is one of growing cities, effectively waterproofed and designed to get rid of water as it falls. With this goes an increasing thirst on the part of cities, causing them to reach out unbelievable distances for their water supplies, smugly confident that the hinterlands continue to accumulate water in orderly fashion, if the cities themselves do not.

This child-like faith of the city man is sadly misplaced. Well-designed experiments show that in all but the most skillfully managed agriculture the power of the earth to absorb moisture and delay runoff is greatly reduced by destruction of the natural vegetation, whether it be forest or prairie. Perhaps the most striking example comes from the work of Warren Thornethwaite at Seabrook Farms, New Jersey, in disposing of some 8,000,000 gallons of waste water a day. At first he tried spraying this onto agricultural land of various types. It soon became saturated and would hold no more. But when he sprayed it over the forest, the entire

amount—equivalent to some 500 inches of rain a year—readily was absorbed. This process has been going on throughout the growing season for several years with no ill effects, resulting in a dense undergrowth such as is seldom met outside the tropics.

From test-plots in Oklahoma, Ohio, the Rocky Mountains, and doubtless other places as well, comes the same story. Land covered with native vegetation or a reasonable facsimile thereof will absorb water. Land cleared and subjected to ordinary agricultural treatment loses from half to two-thirds of its capacity to absorb. And it is upon water that is so absorbed, or otherwise retarded in its return to the ocean, that all terrestrial life depends.

Civilization, with its growing centers of population and industry, its rising standards of sanitation and convenience, has a vast and growing thirst. Along the flood plains of great rivers it sets hostages in the form of rich farms and costly urban structures. Elsewhere its roofs and roads waterproof the earth, while an ill-considered agriculture makes the earth less permeable, and rectilinear highways supplant the old and leisurely watercourses. Perversely, waste and want walk hand in hand. Civilization represents a state of increasing hazard with respect to water.

These statements can be documented as scrupulously as the readings in a laboratory. Yet for remedy we have chosen to prescribe for ourselves hair from the dog that has bitten us—more of the same, and yet more.

So it is no journalistic whimsy that the man who some years ago engineered a book called *Cities Are Abnormal*

is now writing of *Big Dam Foolishness*. He is calling upon us to re-examine our child-like trust in steel and concrete and to consider instead the ways of nature. For natural processes were handling the regimen of water long before we came on the scene, and doing it very well. All Elmer Peterson asks is that we take advantage of this fact to the fullest extent.

This, it seems to me, is good science and good sense, and good citizenship as well. In saluting Mr. Peterson, I cannot restrain a measure of embarrassment that a journalist has had to do what some three generations of science teachers might have done for their students who now comprise the American public. For if we had not been content to teach science in technical fragments, out of context with nature and with the rest of human knowledge and experience, this book would not have been necessary.

Democracy and freedom rest upon the assumption that the average man, given the facts, will ordinarily make the better choice. Without knowledge we have not democracy and freedom, but a dog-fight. It is the clear function of science in political affairs to narrow the zone of conflict to matters of policy by furnishing the facts. Without freedom there can be no science. Certainly men of science are devoted and preoccupied, deserving some exemptions. But if they choose to slight their duties as citizens, the first to be neglected are those upon which the self-preservation of science depends.

PAUL B. SEARS

Yale University Conservation Program,
New Haven, Conn.

Contents

PART THREE

THE AGRICULTURAL FLOOD CONTROL SOLUTION

PART FOUR

A LAND WITHOUT FLOODS

Foreword

This book, frankly, is controversial and somewhat iconoclastic.

It is intended to smash into a sixty-century-old thought pattern and question certain petrified concepts that seem to have been taken for granted by those who deal with the behavior of natural water.

The book is expected to arouse the criticism of those who stick to the old conventional pattern. On behalf of a rapidly growing school of thought which rejects that pattern, it is hoped that the critics will meet the main issues of this book with a fresh set of arguments, without resorting to the hackneyed formulae of which the following are typical:

"Mr. Whoozis doesn't claim that floods can be prevented by watershed treatment."

"If the big Crazy Horse Dam hadn't been built, the flood below it would have done $476,852 more than the $9,760,009 damage it actually did."

"Let's have both watershed treatment and big dams in the Middle West."

"The rapid fill-up by siltation of big reservoirs isn't

our problem; let the next generation worry about that."

Above all, let the critics meet the statistical realities. Let them prove by facts and figures that the big reservoirs impound more runoff flood water than a multitude of little ones: or let them confess their failure. Let them cite actual results of comparative demonstrations, not theoretical "design floods" or guesses.

As this book is written a critical battle is shaping up, its focal point being in Kansas—midway down the western part of the Mississippi Valley. It is a battle between those who think flood control is best achieved by huge storage reservoirs and those who contend that water—even in abnormal amounts—can be stopped where it falls, or near that point.

Dwight Payton, energetic young newspaperman who is president of the Kansas Watersheds Association, has predicted that this battle will be the chief political issue of the immediate years ahead in his state.

This book is not thus dated, however. Its theme deals with at least 6,000 years of a vital aspect of recorded history, and the argument will probably go on for a long time.

Because of various circumstances, the writer has been in the thick of the battle, attracting the slings, arrows and brickbats of powerful interests, not because he was picking a fight but because he began advocating upstream flood control as opposed to big dams, as early as 1910, using the slogan, "Dam the Draws," in his little weekly newspaper. Incidentally, the big dams of that period were owned by private enterprise—sometimes

called the "power trust" by advocates of public power—so one of the arrows is blunted.

Since about 1950 the writer has been chosen as a special target by the promoters of big dams, even to the extent of attracting a ten-page blast by a Congressional subcommittee, and being the subject of a lengthy treatise by the Army Engineers.

One aspect of these attacks is especially conspicuous. That is, that the propagandists who insist that agricultural flood control "will not control floods on the main stem" never produce engineering or other statistical material of actual performance to support their thesis.

A contemporary publication purporting to describe the flood control controversy is typical of the propaganda put out by the general school of big-dam defenders. It takes a hypothetical watershed, with theoretical percentage of coverage, hypothetical gradient, theoretical soil-type, hypothetical conservation insoak treatment, theoretical height of dam, hypothetical rainfall of theoretical duration, hypothetical terracing, unknown crop-or-pasture program; and by imposing a "design" flood it comes up with the glib contention that watershed treatment alone can't do the flood control job. It even makes the astounding assertion that a "design" (hypothetical) flood furnishes a better criterion for evaluation than actual performance. In the meantime the Washita basin projects show a perfect record of performance by surpassing advance estimates. This publication also fails to answer the many points of indictment that have been made against big dams.

There has been such a widespread demand for facts and figures that this book was written in an effort to gather the main data for the convenience of inquirers.

The material includes a compilation and co-ordination of the writer's own articles and editorials in the *Saturday Evening Post, U.S.A., Farmer Stockman, Oklahoman, Oklahoma City Times, Country Gentleman, The Land, The Rotarian, Reader's Digest, Colorado Wonderland, Farm Journal,* and other publications, and speeches made to the Izaak Walton League of America, the American Wildlife Institute, St. Louis Farm Club and chapter of Friends of the Land, the Kansas Watersheds Association, numerous conservation or flood control conferences in Oklahoma, Kansas, Nebraska, Missouri, and elsewhere. Since the picture is constantly changing, new material was included up to the time of going to press.

The writer wishes to acknowledge his gratitude to Mr. Karl Hess for his creative work in editing the manuscript for publication.

For encouragement and assistance he is indebted chiefly to E. K. Gaylord, president of the Oklahoma Publishing Company, who, as employer, has shown great patience and long-suffering in acquiescence to the writer's humble part in this crusade. Others who have given notable assistance are many officials of the Soil Conservation Service who request anonymity; Dr. Paul B. Sears of Yale University, to whom I am especially indebted for an introduction to this work; Phil Zimmerman of Topeka; the members of the Blue Valley

Study Association; R. C. Longmire, Dave Vandivier and other officials of the Washita Valley Council; Henry B. Bass of Enid, Okla., L. W. Rittenoure of Wichita; Director William Voigt of the Izaak Walton League; Ferdie Deering, E. E. Blake, Walter C. Gumbel, Courtlandt Eaton, Waters Davis, Frank Dunaway, A. P. Atkins, Harry James, Don Berry, Arthur H. Carhart, Bud Jackson of the American Wildlife Association; Edward Beecher, Dr. W. A. Albrecht, and Gus Beilmann of Missouri; Roy E. Hayman; Jess Dewees; L. L. Males; J. Frank Relf; Russell Lord; Dr. Jonathan Forman; Ollie Fink; Louis Bromfield; Paul Nels Carlson; Ray McConnell of Nebraska; Dwight Payton of Kansas; Bert Keshlear of Iowa, and Jay N. Darling, to whom the writer owes a special debt of gratitude for his fearless leadership and his help and inspiration. There are so many others, particularly in Oklahoma, deserving of mention, that one would not know where to begin or end—literally scores of fine citizens in Farm Bureau circles, FFA, county agents, 4-H Clubs, conservation district leaders, civic clubs, extension departments, University of Oklahoma and Oklahoma A. & M. College.

It has been a good fight.

The most conspicuous element in this fight has been the enormous infiltration of political power of those who cling desperately to the big-dam concept because it is a convenient mechanism for the appropriation and distribution of the taxpayers' money.

Time after time it has seemed that the watershed policy would win, but defeat has come because the ingen-

ious and potent techniques of the pork-barrel have been effective. The politicians in such cases have taken the easy route of succumbing to the blandishments and technical gobbledegook of a deep-rooted bureaucracy, using huge and spectacular baits instead of standing beside the lonely farmer at the forks of the creek, working on his quarter-section of disintegrating land. Then there have been the appeasers with their seductive plea —"Let's have both conservation *and* big dams," and when the score of the latter equation is added up, it is found that the big dam gets the money.

Let the fight go on. Reinforcements are on the way. The on-coming generation, particularly in the FFA and 4-H Clubs, is learning much about the modern and scientific methods of flood control. We must look to these youngsters for leadership in the days ahead.

Oklahoma City, Okla. ELMER T. PETERSON
October, 1954

PART I

THE PROBLEMS WE FACE

CHAPTER ONE

Water Against the Land

There always are shadows on the land. Once an ax handle cast the shadow, and a westward marching nation, hacking and burning as it went, left a heritage of stumps.

Then a moldboard plow cast its shadow on the land, as its blade turned and buried the topsoil and also buried the good, green hope of eternal, good crops.

Or, there was the dusty shadow that stretched from Eagle Pass to old Fort Dodge, of a million moving cattle packing the soil from which the grass had been torn.

Then the shadows faded. New shadows, of men planting seedlings, of disc harrows and cultivator rakes, of sleek cattle in lush, live clover, were cast. The farmer wipes his brow, stops, looks at the promise of the land and sees the shadows as pictures on the land—as good as the passing swoop of the red-shouldered hawk before the sun.

It is easy for him, and for all of us, to skip the big,

looming shadow that covers all the others; the shadow cast by a billion tons of looming cement, soaring from the riverbeds—the shadow of the dams.

The big shadow has become too familiar for notice. It is a part of the scenery now. Its shadow is part of the day. But what goes on behind the shadow?

The dam generates power, to help the farmer, to build the cities, to light the world. The dam brings the boats onto the sea-seeking watercourses to move the ships of trade onto the wider waters of the world. The dam flumes its water onto the parched lands to quench the thirst of the crops.

The dam, its builders say, does all these things and more. It symbolizes the new philosophy of men bent upon changing the shape of the land—and the world. It is man's proud boast, flung straight at all of nature. It is a triumph, not a shadow, they say.

There can be no argument, furthermore, because the dam is *inevitable*. It is not a whim, a mere device, but a fact of life. And then the builders smile, because they "have you there." Why, without the dams, we couldn't stop floods! Now the shadow is clear. The big dams, beyond all quibble about details, of philosophy, of justice, of politics, of ecology, are needed to stop floods.

And with that, the builders banish the shadow. With that they ultimately justify a mob of questionable "multiple purposes."

And for that, an entire nation may someday pay with its life.

There is no other less or more dramatic way to put it.

Like all the other shadows, each of which put our

land literally and precisely in risk of its life for a time, the shadow of the dams over the plowland is a long, darkening threat of disaster. It is not explosive disaster like that of a bomb. But it is as total. It is not an alarming threat because it is a long, long-range threat.

Yet it is a simple threat to state, although amazingly complex to analyze. It is stated, perhaps, as simply as this:

Dams on the plowlands fight nature. They do not work with nature. Thus they are disruptive. They are disruptive of the water on which the soil depends. Each new dam, in this disruption, potentially requires that another be built to handle the upsetting caused by the first. And each and every one absolutely requires that, someday, another be built, because each and every one, as it fills with the inevitable silt, becomes gradually useless. It is a spreading cancer of dams that is the danger, each one nibbling away at the fertility of the land; each one taking men farther away from nature's demand that water be held, not in vast man-made pools, but on the land where it falls.

Running through all of this, like a thread of irony, is one more simple yet appallingly tremendous fact:

Dams do not stop floods!

Any uncontrolled flow of water that removes objects from their natural and most useful location is a flood. It is also an agency of erosion. In principle it makes no difference whether the eroded object is a particle of earth or a railroad track and, in principle, it makes no difference whether the flow of water is an enormous torrent or a tiny, escaping trickle. The damage consti-

tutes essentially the same basic problem. The destruction simply is proportional.

Engineers of the United States Department of Agriculture through research have determined that from 75% to 85% of all agricultural flood damage occurs on tributary watersheds, leaving 15% to 25% for the comparatively narrow zones on the flood plains—below the spots where the promoters of large dams propose to build their structures.

Here it is well to say that this book is aimed almost entirely at the problem in the plowlands, since the matter of building dams in mountainous regions or other localities completely protected by vegetation constitutes a separate problem which is mainly outside its scope.

The point to be made here is that in these prairie plowlands, damage to agricultural production ultimately means damage to almost 100% of the total economy of the region, since agriculture is basic. We all have to eat. To put the case in different words, the destruction of factories, railroads, homes and other urban establishments is unimportant compared with the permanent damage done to fertile topsoil.

In analyzing the flood problem we must consider the basic fact that water in motion, flowing *over* raw soil, is a continuing national peril, and that its ultimate total destructiveness is seen to *increase* as the exploration moves up the slope. It does not *decrease,* as most promoters of big dams would have you believe.

In the past 6,000 years in other fields, there have been prodigious transformations in human living accompanied by invention, research, revolutionary discov-

ery, and the perfecting of mechanics, physics, chemistry and medicine. But in the case of water—so tremendously important to all of us—we still rely upon the cruder techniques of mechanical engineering, disregarding the complex of a dozen other sciences standing ready to help. Particularly we disregard the applied sciences that deal intimately with the hydrologic cycle.

A large section of the people still view the operations of the hydrologic cycle with unseeing eyes. Evaporation from the ocean, the trail of vapor to the inlands, precipitation, the behavior of water as it strikes the ground, seepage into lower levels, the phenomena of springs and flowing well water, the benefits of water to growing vegetation, the floods that often occur—all these seem to be regarded as the enactment of mysteries beyond our knowledge or control. Actually these phases of the hydrologic cycle are easily understood by anyone who gives even slight study to them, and it is seen that some of the most important manifestations are controllable by man. We find, for instance, that when we use a combination of many modern sciences in an eclectic pattern, a cloudburst of 13 inches falling within 24 hours can be controlled on a watershed. We find that far more water can be stored in the ground than in the greatest surface reservoirs. Most important of all, we find that the topsoil contains a stupendous complex and concourse of vital organic and inorganic substances upon which life depends, and that the washing away of these substances means "Deserts on the March," with sure death in their wake. We also see the most obvious object lessons in history.

The death of many an empire—Babylonia, Carthage, Rome, Greece—is registered in the sedimentation of its rivers and canals, simultaneously with the erosion of its slopes. But our water policy leaders blandly ignore sedimentation or dismiss it briefly under the head of "pollution" and concentrate their attention upon the crude methods of 60 centuries ago, which actually *cause* sedimentation instead of preventing it. That is, they concentrate upon the manipulation and trapping of muddy water—land-soup—in huge volume, oblivious to what history has to teach.

It seems high time to re-examine the whole flood problem. Our present national flood control program is failing miserably. An examination of the nature of our floods and the damage done by them shows the reason for the failure.

The economic loss due to floods is beyond calculation.

Every time there is a major flood someone estimates the damage. Such guesses are bound to be "shotgun estimates," because there is a broad zone in which urban properties and installations merge into the rural, and the latter area is extremely hard to delineate.

High government officials estimated that the Arkansas Valley flood of 1943 did $127,000,000 worth of damage. Nineteen lives were lost. The Vanport (Oregon) flood of 1948 drowned 40 persons and it did $200,000,000 worth of property damage. The Dayton (Ohio) flood of 1913 cost more than 300 lives and a property damage in excess of $100,000,000. The historic Johnstown (Pa.) flood of 1889 drowned 2,250

persons and cost $10,000,000 in property damage. Destructive floods in the Mississippi and Ohio valleys have recurred, again and again, each time with enormous destruction. The Kansas-Missouri flood of 1951 was still fresh in memory when this chapter was written. It, too, brought catastrophic losses.

According to estimates of the National Association of Manufacturers, this flood left 16,000,000 tons of mud in the Kansas City bottoms. Removal of the mud and its damage to urban installations and property were properly charged against the flood. However, the newspaper writers, the Army Engineers, the politicians, and many other observers completely missed the most vital and important economic element in the calculation, which was the escape by erosion of this rich, stinking mud from the watersheds of Kansas, which constitute the trade territory of Kansas City, St. Louis, Topeka, Manhattan, Lawrence, and other urban centers. This omission becomes all the more amazing when we consider that the deposit in the Kansas City bottoms was only a small fraction of the total amount that went down the Missouri and Mississippi into the Gulf of Mexico. The soil scooped up by the post-flood bulldozers and draglines, as of normal location, was worth $2.00 a ton at commercial rates, so that phase of the damage mounted to at least $32,000,000. The total loss, by such a calculation, must have been at least a billion dollars.

But even that loss is habitually underestimated, because the soil is capital which cannot be replaced. When left in its proper place it produces wealth, century after century. Added to the cold-blooded economic loss due

to its dislocation is the more intangible but all-important loss to human health and welfare registered in the increased inability of the soil adequately to support human life. We could ignore all the damage done to railroads, factories, warehouses, and homes in the Kansas City bottoms and still say that the damage to the base of Kansas City's wealth was far into the billions of dollars. By comparison, this factor of damage, makes the immediate and obvious urban damage seem trivial indeed. Yet it was wholly ignored by the headliners, news photographers, Army Engineers, politicians, and short-sighted town boosters who seemed completely obsessed by the obvious spectacular phases. This primitive approach to the subject is the worst obstacle to a proper evaluation of the flood peril.

The writer, addressing the St. Louis chapter of Friends of the Land and the St. Louis Farm Club in 1951 (the audience included the president of the St. Louis Chamber of Commerce), suggested that the Chamber ought to hold at least one meeting a year on Eads Bridge, there to engage in silent meditation and prayer over the prodigious wealth that could be seen quietly flowing down the Mississippi River, without even the impetus of big floods, hour after hour, week after week, year after year. Engineers estimate that every year a total of one cubic mile of soil passes New Orleans. The water is always muddy. That is the telltale sign. It is land-soup, carrying away the very lifeblood of the valley farmlands.

Even in moderate rains it comes out of cattle-yards,

sewage, decaying compost, old strawstacks, forest mold, open plowed fields, overflowing marshes with green and slimy biological accumulations. It has a nasty odor, but it contains countless trillions of micro-organisms, trace elements, elusive substances most of which confer life and health.

According to Dr. H. H. Bennett, former chief of the U. S. Soil Conservation Service, each year, on the average, we lose 117,000,000 tons of major elements like calcium, phosphorus, potash, sulfur, nitrogen, etc., through erosion, whereas cropping and grazing remove only 19,000,000 tons.

Sears, Vogt, Osborn and many other authoritative writers have repeatedly warned that we are losing our land-lifeblood at a frightful rate, but, so far as the politicians are concerned, their pleas fall too often on deaf ears. We, as a nation, are now bemused by the notion that this is still a virgin country whose soil is a storehouse of inexhaustible wealth. We do not realize that we have lost by erosion the equivalent of one-third of our topsoil since our forefathers' plows first turned the land.

We spend increasing millions of dollars for processed phosphates, nitrates, potash, calcium, etc., to put on the soil to restore its fertility, yet we view with complacency the removal of the same elements by rainwash, in greater volume than what we add artificially.

This wash of fertile elements and substances into the sea may be good for the fish and other sea life, but it is hard on human beings and their livestock on the land.

Despite enormous spending by government agencies on works designed for flood control, the damage grows and grows. We seem to be caught in a pattern of cumulative water-disaster. The shadow remains on the land.

CHAPTER TWO

A New Approach to Flood Control

Federal participation in flood control came about in a natural way. Major floods are almost invariably of interstate character so, in the early days of the nation, lawmakers reasoned that federal resources and power should be involved. Then, because the pattern of a military corps makes it especially convenient and valuable in drastic emergencies, it was not long before the Army Engineers were called upon to act quickly and efficiently in supervising the building of levees and other structures when great floods came.

The picture that grew from these early and genuine heroics became a sort of national favorite. The grim, strong men saving the levees, evacuating the towns, aiding the stricken were a peacetime reminder of selflessness, discipline, and strength that helped keep the faith a bit stronger in all of us. The point was that our Army, serving our country, was saving some of our land and our people. And this was fine. Perhaps you could say it

was better than fine, that it was touched with greatness and stature in the way of much often-maligned military action.

So long as the Army Engineers acted as servants of the people, they were exceedingly effective. However, a gradual change has taken place in which this Corps has assumed an active and aggressive propaganda policy, employed extensive public relations departments, and moved in as a promotional agency to initiate a swollen and almost uncontrollable series of civil functions. The old heroisms are gone. In their place are bureaucratic maneuverings and theorizings that are pale, distorted shades of the former fullness of military service.

In 1944, the Pick-Sloan Plan was evolved as a combination and co-ordination of the previously overlapping programs of the Army Engineers and the Bureau of Reclamation. A high water mark in this ambitious program was seen in the meeting of the National Reclamation Association at Oklahoma City in November, 1948, when the Army Engineers produced a huge exhibit outlining a civil functions program, chiefly huge dams, involving the spending of $57,000,000,000 under this plan. There was not even a pretense that the people of the United States had asked for such a program. It was born in the fertile minds of Washington bureaucracy.

Pork-barrel politicians welcomed the program because it meant a colossal maneuvering for funds to be spent in their own districts. Nevertheless, there were uneasy complaints in Washington officialdom, evidenced in disclosures of vast waste and extravagance, bungling advance estimates of costs, and the like.

Beginning about the year 1945, a rebellion began to form as the excesses of the Army Engineers became more evident. The Mississippi Valley became the scene of a vigorous controversy between big-dam supporters and those who believe in watershed flood *prevention.* The basic issue thus came into focus; that is, the old conflict between those who believe in powerful centralized federal government and those who cling to the idea of decentralized local self-government, with a maximum of popular control.

The Army Engineers continue to be aggressive and they proclaim that the Flood Control Act of 1936, with amendments, confers all flood control prerogatives upon them, under the sole principles of mechanical engineering, that is, using surface storage, levees, and the huge structures. They cannot prove a clear title, however, because there is a double-talk aspect to this legislation which confers certain functions, under "Agricultural Flood Control," upon the U. S. Department of Agriculture.

This has caused confusion and uproar, and the political and bureaucratic exponents of the Pick-Sloan Plan have attempted to set up an imaginary man-made dividing line in which USDA is supposed to take care of floods "on the tributaries" while the Army Engineers retain a grim and uncompromising grip on what they call "downstream control on the main stem." This division of jurisdiction turns out to be theoretical, after all, when analyzed, for the simple reason that if floods are prevented on the watersheds—on the tributaries—they

are likewise automatically prevented "downstream on the main stem."

It is axiomatic that the whole is nothing more nor less than the sum of all its parts. If floods are prevented on the tributaries, there can be no floods on the main stem, since the main stem gets its water from the tributaries, the only exception being an infinitesimally small fraction falling on the lower river from the clouds. This exception could not cause floods.

Engineers are supposed to be sticklers for facts and figures as opposed to theories, guesses, or opinions. Yet, at this critical point of divergence, the big-dam engineers fail to produce facts or figures as to the alleged superiority of big dams. The writer has repeatedly, over a period of at least ten years, challenged them to come up with facts and figures for comparison; but they have remained silent on this point. They quibble volubly about other angles which have no real bearing on the merits of the comparison—for instance the exact amount of water that flowed over their Fort Gibson "flood control" dam in Oklahoma in 1950, or what former Secretary Brannan or Chief Salter "do not claim," or what "would have happened" if the (Army Engineers') Pensacola dam hadn't been built. This, incidentally, is a theoretical calculation which falls on its face when you find that the Pensacola dam overflowed three times within eight years, augmenting flood damage below. The engineers' use of slide rules and logarithms is not impressive to the farmer clinging to a chicken coop and watching his earthly possessions float down the muddy flood.

Unquestionably, the monopoly on flood control must

be taken from the Army Engineers. Local communities can control their own floods when they occur on the smaller tributary watersheds. States can do even better, if they will, since their powers of finance and organization are greater.

Since the major floods are interstate, and since the federal government regulates navigable waters, there is still justification for the federal government *participating* in control. By that token there is justification for the federal government assisting in local operations, for instance in soil conservation districts, to bring about the modern agricultural flood control which will be advocated in this book.

The realization of this proposition has brought about a shifting of emphasis back to local communities, even to individual farms.

The necessity for this new approach involves deep-laid human rights and orderly functioning of the democratic process. For instance it is increasingly recognized that a rich farming community like that of Blue Valley, in Kansas, should not be deprived of 50,000 acres of its richest land by virtue of arbitrary actions by federal officials, however benevolent their ultimate overall intentions may be. The people of that valley have the greater inherent right, through the democratic process, to determine what shall be done with their own best resources, which they developed and nurtured. Autonomy thus becomes of paramount importance.

The writer, in the spring of 1953, talked with the editor of a newspaper in Mitchell County, northern Kansas. In substance, the editor said:

"If that big federal dam is built at Glen Elder, it will

mean that half of Beloit's trade will disappear, because the richest part of our trade territory will be inundated by a huge reservoir. The people are against it, but it seems there's nothing we can do about it, because the higher-ups have ordained that the dam must be built." If this high-handed policy is not "taking property without due process of law," it certainly comes so close to it as to violate the spirit of one of our most cherished constitutional guarantees.

In Missouri the farmers, members of the Ozark Protective Association, resisting a proposed dam on beautiful Current River, were told to appear at 10 A.M., nearly 200 miles away, in Arkansas, if they cared to be heard by the Army Engineers. Arriving there in three bus-loads, they were blandly told that they couldn't be heard until 5 P.M. Any one with milking or other chores to do knows what that meant. This episode is reminiscent of one section of the Declaration of Independence, which says: "He has called together legislative bodies at places unusual, uncomfortable and distant from the depository of their public records, for the sole purpose of fatiguing them into compliance. . . . He has erected a multitude of new offices and sent hither swarms of officers, to harass our people and eat out their substance. . . . He has effected to render the military independent and superior to the civil power."

One of the best devices for restoring autonomy is the setting up of conservancy districts under state laws, whereby local communities can initiate whatever action they see fit, without incurring federal interference. Ohio is one state where such a principle is worked out, for

instance in the admirable Miami Conservancy District and Muskingum programs. The states and communities have the most vital stakes. They should be first consulted.

One of the most promising agencies for the restoration of local self-government in this respect is the smaller soil conservation district, approximately the area of an average county, which is the result of joint action by federal and state governments in all of the states.

The soil conservation district is an excellent example of democracy in action.

The federal Soil Conservation Service (under USDA) specifically limits its functions to those of technical assistance, leaving matters of government to actual farmers and land-owners who are most concerned. The writer belongs to such a district, having a farm of his own, and is familiar with the procedure. In the local and state meetings a noticeable fact is that actual "dirt farmers" run the show.

Getting down to the very grass-roots, literally as well as figuratively, the technicians and officials meet with individual farmers and discuss the various problems on the land, so that even a 40-acre farm may be integrated with the county-wide and state-wide program of stopping water where it falls.

Thus we see the necessity for a readjustment in which certain unique elements of federal action are combined with the town-meeting aspects of the rural soil conservation district association.

The average farmer is reasonable and he appreciates the value of certain federal functions. There is no rea-

son why the flood control program should not be re-shuffled, in harmony with modern technical and scientific facts, so that a proper and wholesome balance between Washington and Walnut Creek Soil Conservation District is achieved, and the principle of the Ohio conservancy district is spread into all appropriate quarters.

In view of modern scientific findings, the U. S. Department of Agriculture is far better equipped to superintend all flood control functions on watersheds where land use is a factor. In any event no flood control program should be approved without first having the approval of divisions having to do with agriculture, forestry, biology, wildlife, health, economics and related fields, and of local groups of citizens, wildlife associations, conservation associations, and other appropriate bodies and individuals.

In 1952 the House Appropriations subcommittee heard an amazing recital of testimony by expert engineers as to the failure of the Army Engineers' Missouri Flood Control Program, costing $250,000,000. Space forbids quotation but no one who claims to be interested in flood control should fail to read its report. In brief, this report showed that floods are worse on the Missouri River than before this vast program was begun, and that river navigation is a dismal flop. The document is entitled, "Missouri River Channel Stabilization and Navigation Project," and is dated June 30, 1952. This civilian estimate produces serious doubt that the Army Engineers really understand large scale flood control.

CHAPTER THREE

An Unhealthy Conflict: Army Engineers v. SCS

Watershed agricultural flood control is potentially one of the biggest news stories of the century, comparable to the revelation of atomic power. But it threatens to die on the vine because of the blundering of selfish bureaucracy, the narrow specialism and purposeful quibbling of technical groups, and attempts at appeasement and the blind selfishness of the few who think they will profit by the perpetuation of the 6,000-year-old patterns of spectacular but unscientific and ineffective downstream structures—the dams.

As indicated in Chapter 2, there is a basic and inherent conflict between the big-dam promoters and the Soil Conservation Service, which operates under the U. S. Department of Agriculture. The nature of this conflict will appear more clearly as we delve more deeply into the subject; it is usually kept hidden from the pub-

lic. It is disavowed and denied by top echelon officials on both sides. However, the writer has seen well-covered documents and has had many confidential conversations with SCS men who are out on the firing-line—the practical technicians who best understand the principles of watershed flood prevention. Many of them are bitter. Still more of them are cautiously resentful of the Army Engineers' domination. Many honest SCS technicians are likewise resentful of the appeasement tactics followed by high-up officials in their own department. This is not a healthy condition. It ought to be brought out into the open instead of being kept buried.

The SCS is committed by law to a flood *prevention* program which top Army Engineers feel bound to repudiate, since they refuse to admit the validity of any "FC" program that is not dictated by themselves. The SCS is too weak to assert itself as aggressively as the Army Engineer Corps, and it is maneuvered into a one-way "compromise" in which the logical conclusion would be the extinction of agricultural flood control.

The bone and sinew of the SCS is furnished by local and state soil conservation district associations and supervisors. On this front the leaders are not afraid to speak out.

A. P. Atkins, when president of the Oklahoma state association of conservation districts, wrote in the official organ, *The Soil Saver,* issue of October 1, 1950:

"The conference report of the U. S. Senate and House of Representatives on the General Appropriations Bill for the year 1951 . . . is a rather complicated book of 72 pages, written in technical form . . . not easy

for a layman to understand. . . . Here are some of the totals:

Army Engineers	$383,408,000
Bureau of Reclamation	295,828,000
PMA (Conservation payments only)	282,500,000
Soil Conservation Service	56,208,000
Agricultural Flood Control	10,315,000
Total	$1,028,259,000

On the basis of a dollar, each agency's share would be approximately:

Army Engineers	37c.
Bureau of Reclamation	29c.
PMA (Conservation payments only)	28c.
SCS	5c.
Agricultural flood control	1c.

"Agricultural flood control (Washita style) is new . . . but it has already proved its effectiveness. . . .

"Now look at the appropriation for PMA's so-called conservation payments. Admit that a substantial portion is now spent on permanent structures and revegetation, which are the basis of agricultural flood control. It still contains no inducement for comprehensive soil and water conservation. . . .

"Every voter should demand: 1, No more dams without protection of the watershed above. 2, No more conservation payments without a reasonable guarantee of complete protection for the entire farm."

Mr. Atkins' context indicated keen resentment against the tremendous expenditures of the taxpayers' money for the Army Engineers' and Reclamation Bureau's programs, compared with the "peanuts" handed

to the SCS for watershed flood prevention and control. It might be well to explain that his criticism of the PMA payments is a part of a rapidly growing opposition to the "gentle rain of checks" first introduced by Henry A. Wallace in his effort to socialize agriculture in the 1930's. Such "gifts" are closely related to the pork-barrel pattern of the big-dam builders. They obviously are of a political nature.

The Oklahoma association at one of its meetings also denounced these "conservation payments," insisting that available federal funds be spent for genuine conservation work, under SCS technicians. It has repeatedly demanded that the agricultural flood prevention work on the watersheds be completed *before* big dams are constructed, but politicians pay no attention. It should be remarked that these men of the district associations are genuine dirt farmers, who know the score—not politicians or theorists.

When the Inter-Agency hearings are held, common-sense propositions like the one advanced by Mr. Atkins are quickly buried under mountains of gobbledegook. The foregoing tabulation indicates only tiny and random fragments of the vast web of political intrigue and mis-appropriation of tax money which is hampering clear thinking and direct action.

The promoters of traditional bureau procedures revel in a turgid sea of technical calculations. They have little difficulty in getting the average citizen confused. Apparently that is precisely what they want.

Instead of taking a few incontrovertible facts, which show the most effective avenue for flood control and

conservation, and sticking to them in the Inter-Agency and Congressional hearings, they divert discussions to allocations of power, flood control, and irrigation, navigation, work plans, benefits, priorities, overall basin policy, grid systems, integration with REA, and other technical matters which soon have the layman floundering. He can't use a slide rule or table of logarithms, and if a federal big-dam engineer dominates a hearing with copious, learned and theoretical discussions of what damage a given flood "would have done" had it not been for a given big dam, he just can't keep up with the conversation.

There is no indication that the big-dam promoters who dominate the Inter-Agency hearings have paid attention to the vast volume of dissent that has arisen from farm groups and various individuals who have appeared with vigorous arguments in favor of watershed flood prevention. The final decisions are uniformly on the side of the big dams, no matter how convincing the case presented by the opponents.

Probably the reason for their unique method of settling an issue by deciding the case in their own favor is found in their oft-repeated contention that the Army Engineers have the sole prerogative of determining proper control "on the main stem." What they are saying, in effect, is:

"Your arguments may be good, but they are irrelevant, incompetent, and immaterial so far as downstream flood control is concerned, because the Flood Control Act of 1936, with later amendment, conferred upon the Army Engineers the supervision of downstream

flood control. Even if you are right, you are obviously wrong. Keep on your own side of the fence."

This contention has produced endless argument in flood control and conservation circles. Since the SCS of USDA is bound by the Inter-Agency Committee, which is clearly dominated by the Army Engineers, some of the top echelons are obviously embarrassed and intimidated.

A revealing passage-at-arms took place on February 15, 1954, during consideration of S. 2549, known as the Hope-Aiken Bill, which provided for the strengthening of the functions of the USDA in flood prevention.

Gen. S. P. Sturgis, chief of Army Engineers, ridiculed the flood prevention function of the bill, saying "flood prevention is a misnomer." Later on, discussing specifically the Salt-Wahoo watershed program in Nebraska, he said: "Our dams proposed for the protection of Lincoln are in a ratio of, we will say, 1.15 justification. If some of these dams upstream are built as planned, then there may well be a question as to whether we will have the economic justification necessary, as prescribed by the Bureau of the Budget and the Congress, for the building of a dam to protect Lincoln adequately from major floods."

Translated from technical lingo, this meant that Gen. Sturgis feared that the watershed program would work so well that his own big dams would not be justified. Senator Clinton Anderson of New Mexico, pointedly, in substance, asked if that were not true. Gen. Sturgis devised a way of extricating himself from the

embarrassing position, but the implication was not lost on the listeners. Senator Anderson, near the end of this colloquy, pinned Gen. Sturgis down with this question: "What is wrong with stopping the water at the headwaters so it doesn't rush down and flood those communities?" Gen. Sturgis replied: "There is nothing wrong with it, if it can be done. But it cannot be done."

In any event—whether the reader believes that Gen. Sturgis or Senator Anderson had the better of the skirmish—the fact remains that Gen. Sturgis openly and emphatically expressed his opposition to the bill, so, as one reporter said, "the cat was out of the bag." In the face of this authoritative statement by Gen. Sturgis, how can anyone say that "there is no quarrel between the Army Engineers and the USDA?" Of course the USDA-SCS men knew all the time that the Army Engineers were fighting them, so their own appeasement tactics look decidedly inept.

One of the clearest statements of SCS policy was found in a letter to the publisher of this book, written May 29, 1953, by Edward H. Graham, Assistant Chief of the Soil Conservation Service. He wrote:

"We have held that there are three parts to the flood prevention job: (1) land treatment, (2) water detention structures of comparatively small size, and (3) where necessary to supplement the above, large structures such as levees and dams."

Judging from frequent utterances, the Army Engineers resent the idea of having their own operations considered "supplementary." On the contrary, they assert

with no little vehemence that they are running the main show of flood control, and what the SCS does is only "supplementary," or downright insignificant.

However, the "joker" in the SCS formula is the little phrase, "where necessary." It is the escape clause for both SCS and the engineer corps. It provides a loop-hole big enough to drive a truckful of Army Engineers through to the Promised Land, and to admit all the SCS "do-not-claim" officials who want to "get along" with them under that fateful Inter-Agency compact.

If a multitude of small reservoirs will furnish up to four times as much storage capacity as one big reservoir draining the same watershed, at lower cost, obviously the big reservoir is only a poor second choice. Elsewhere in this book are presented facts, figures, and expert engineering testimony which demonstrate the clear superiority of the small-reservoir program. We still have Mr. Graham's second point to fall back upon, with other startling facts and figures in this connection.

On June 4, 1953, Col. Vogel of the Corps of Engineers declared in a four-state soil-conservation meeting in Oklahoma City, that "there is no conflict between the Army Engineers and the Soil Conservation Service." This statement is typical, not only of the Army Engineers, but of some of the top echelon SCS officials.

A mere statement of admitted facts quickly dispels this pleasant illusion.

The record is full of bitter and antagonistic statements made by high Army Engineers. For instance Gen. Lewis A. Pick, as Chief of Army Engineers, testifying before the House Committee on Public Works, July 31,

1951, made certain dogmatic statements about watershed flood control. They depart so far from the actual demonstrations of SCS projects that they seem wild and reckless, ill befitting a profession which claims to insist upon strict technical accuracy rather than mere opinion.

Gen. Pick ridiculed the agricultural flood control program of SCS, saying:

"There has been a widespread *theory* that you can control floods by building small reservoirs over a wide area . . . I do not subscribe to that for this reason: In my *opinion* . . . you would have to provide much greater storage than you could afford to build, in order to prevent these floods, and you would take up much more land . . . You would have to build a terrific number of small reservoirs . . . It would cost terrifically to build enough small ponds over that area." (Emphasis supplied.)

Farther on, he said: "I believe that soil conservation practices established over a drainage area will hold back some of the water . . . If the land is parched and dry, I believe it would hold back the goodly part of a half, three-quarters or an inch of rainfall, if it fell slowly. Perhaps if it fell over a period of several days it would take maybe an inch and a half of rainfall . . . I am not a believer in . . . soil conservation practices being able to eliminate floods."

Both passages are in direct and grotesque contrast to the absence of conflict which Col. Vogel described, besides being contradictory to facts.

Confronted by arrogant and unfounded statements of this kind, which are numerous in the abundant literary

and forensic productions of the Army Engineers, some of the top SCS officials, under the lip-sealing device of the Inter-Agency Committee, have apparently decided to play an appeasement role, that they may hold onto their jobs, and, as one outstanding conservationist puts it, they "drag their feet." They lamely chime in with the Army Engineers, even though their own published statements make their professions of agreement ridiculous and prove that the Army Engineers are wrong.

One of the most unfortunate aspects of this timid agreement is that the SCS appeasers tend to destroy whatever good public relations they would otherwise have. Newspapermen and other writers and publicists have sought to promote the watersheds program by telling of the actual accomplished facts, only to have some of the SCS officials protest that plain statements of the truth are "sensational." If such bureaucrats were to handle all public relations outlets themselves, the story of watershed flood prevention would never get anywhere, and public opinion would fail to get sufficiently aroused to demand the necessary appropriations for the watersheds program. Their tactics therefore tend to defeat their own objectives and stultify the most important objectives of their service. So the public (to whatever extent it may be interested) is confronted by the strange spectacle of laymen desperately trying to get the watersheds flood control program before the public, while, at the same time, certain high SCS men keep throwing roadblocks in their way.

The only thing upon which the lay watershed advocates all insist is to tell the actual facts and let them

speak for themselves. Occasionally some startling facts seep through the iron curtain of technicalities. For instance a brochure of SCS called *Upstream Flood Prevention in the Western Gulf Region* showed, on page 18, a pictorial and verbal description of what happened on the SCS-treated part of the West Owl Creek watershed in Oklahoma, in May, 1950.

There was a picture of a farmer examining his corn crop, which was the first he had been able to harvest in eight years because of floods that had previously wiped out his plantings. There were figures showing that the soil conservation techniques (ridiculed by Gen. Pick) had impounded and absorbed 13.5 inches of cloudburst falling in two days. No Army Engineer, in his wildest moments, has ever claimed that his system of big reservoirs would control any such deluge. In fact it happened that the (Army Engineers') Fort Gibson dam in eastern Oklahoma, during the same period, overflowed because it could not impound its watershed runoff amounting to *about two-thirds of the West Owl Creek cloudburst* on a pro rata basis.

Supplemental figures furnished to me by SCS engineers showed that actual impoundment of the small detention dams in the general area ranged from 4.75 to 5.22 inches. This means that the remainder of the cloudburst had been absorbed by insoak superinduced by SCS practices, with overflow regulated by gradual draw-down so that the creek did not overflow its banks until it had reached a mile beyond the treated portion of that watershed.

To cap the climax it is interesting to know that the

gigantic Denison (Army Engineers') reservoir (Lake Texoma), whose watershed includes that of West Owl Creek, could not possibly impound more than 1.31 inches of runoff, in proportion to watershed area. Even that figure would necessitate an empty "flood pool," a condition which seldom if ever occurs except during prolonged drouths, because the public power and fishermen's interests demand a full flood pool or an approximation thereof.

Despite an abundance of such facts, a high-up SCS man got up in the Oklahoma City meeting at which Col. Vogel spoke and said, without presenting factual or statistical data: "You can't prevent floods on the main stem—you gotta have big dams." And then the SCS men wonder why Congress doesn't give them real appropriations instead of pennies!

The writer has many fine friends in the SCS, many of whom do not go along with the appeasement formulae, and regrets to mention such compromises, but the interested public should realize these points.

Beyond this, of course, what the public should realize is that the matters dealt with in this engineer-conservation dispute is not one of simple method. It is not an honest, open disagreement. It is an arrogant dismissal of facts which have been arrayed to show the way to save our soil and, in its broadest sense, our land. It is as though, precisely, a moldboard-plow lobby had been fully successful in suppressing and denying Faulkner's warning of the Plowman's Folly.

Whether the engineers' reasons are sincere or just misguided (as they must be presumed to be) or cynical

and calculated (as they often are accused of being) makes no difference.

What we are dealing with is survival itself. What we are building for is land to serve an endless lineage of American generations. We cannot afford to sightsee along all the side-roads of personal whim and bureaucratic fancy. Only the facts can save us.

PART II

BIG DAM FOOLISHNESS

CHAPTER FOUR

The Indictment of Big Dams

For every claim to virtue made by the proponents of big dams there is a clear-cut, factual, and demonstrable refutation. Actually, the refutations, lined up together, form one of the sharpest indictments ever handed down against a scheme of man.

In Part I the effort was made to lay the groundwork for this indictment. We discussed the most critical areas of flood damage, the constant worsening of the flood peril, the contrast between two opposing schools of thought, the bureaucratic involvements, the superficiality of the spectacular factor in flood control, etc.

In Part II we shall present the indictment against the big-dam program, especially as it applies to prairie plowlands. Here are the main points of the indictment:

1. In typical key areas it provides smaller impoundment (storage) capacity to hold runoff than the aggregate of small detention reservoirs projected for such areas, especially when flood pool capacities are consid-

ered. It costs much more than the equivalent storage capacity of small reservoirs.

2. It inundates vast areas of the best land in an era when we cannot afford to lose any acreage.

3. It starts a process of backwater sedimentation which, in typical low-gradient prairie streams, spreads indefinitely upstream and into tributaries, with consequent vast damage to our best farmlands.

4. It is characterized by extravagant spending and featured by miserably incompetent preliminary estimates.

5. It is undemocratic, and arrogantly totalitarian in procedure, ignoring the will of the people most vitally involved, and riding roughshod over opposition.

6. It provides inviting war-time targets for atomic bombing, including dangerous contamination of released flood water.

7. It is not needed for power, since steam-generated power in the low-gradient areas is now cheaper than hydroelectric energy, with atomic power close at hand.

8. It is inextricably entangled in the "multiple purpose" reservoir system, in which one purpose directly antagonizes the others.

9. It provides an expensive temporary structure. In the average prairie plowland the big dam has a life expectancy of only about 50 years, because of rapid siltation.

10. It lends itself perfectly to the pork-barrel system, with consequent corruption of politics.

11. It provides virtually no means for raising the general water table by recharge, since its insoak area

is relatively small, compared with the watershed-wide insoak of the SCS system.

12. It is inhospitable to wildlife because of rapid siltation which chokes out spawning beds and destroys aquatic vegetation, and because of variable shoreline.

13. It is integrated with the Missouri River "flood control" program of the Army Engineers, which has actually made floods worse.

14. It is likewise integrated with inland river navigation projects which have proved to be a hoax.

15. Its reservoirs promote evaporation of water supplies, in contrast with ground storage which eliminates evaporation.

16. As inevitably administered through federal agencies governing public hydro power, it promotes socialism.

17. Its value for irrigation is doubtful because of the rapid siltation of canals and ditches carrying the pent-up muddy water.

As this is written (in 1954) it looks as though the big dam is destined to become a prime political issue in a large part of the Mississippi Valley, particularly in Kansas, where the question is hotly debated. As a rule, the farmers tend to oppose big dams. In the larger cities there is divided opinion, though the Army Engineers get more of a hearing, with support from some newspapers, politicians, steel and cement contractors, flood-plain occupants, and miscellaneous groups. The Army Engineers everywhere spearhead the pro-dam campaign, making emphatically partisan speeches, giving interviews, issuing press releases, conducting far-flung

lobbying activities and dominating many meetings of engineering associations. Everywhere the idea is industriously promoted that there is only one authentic type of genuine flood control—the huge downstream reservoir—so the people will take that for granted and laugh off everything else.

The big-dammers seem to want us to believe that a flood is nothing but a malignant torrent that comes roaring down a river from a vague Somewhere, to hit a city, and that its chief crime is destroying urban warehouses, factories, railroad yards and homes. Their whole objective is to wall off the muddy torrent in huge volume, by dams and dikes, or to drain it away as fast as possible. They cling to the ancient concept that you must wait until the evil gets spectacular before trying to stop it.

The watersheds associations take an almost diametrically opposed view. They say that water is a friend, even in cloudburst size, if you know how to handle it while it's still "young." They say a typical flood has already done most of its damage before it reaches a downstream city, and that it could have been tamed if conservation methods were taken on the grass, trees, and furrows, up the little rivulets. Farmers up the creek have a vitally important stake in this dispute. For they have flood problems, too, but thus far they have had rough going. In flood control meetings they are often ignored, shouted down or baffled by glib and trained big-dammers who flourish complex slide rule calculations.

Though USDA engineers have determined by research that from 75% to 85% of all agricultural flood damage occurs on the tributary watersheds, the big-dam men-

tality manifests itself in brushing aside what happens on the fields, in the gullies, and alongside the small creeks, concentrating on the plight of those who, despite ample warnings, insist on living or operating commercial projects in the flood plains of major rivers.

Always there is the spectacular element—the mental picture of shrewd and heroic man challenging, meeting, and conquering a raging monster of the natural world. Mostly this is done in well-appointed central offices, with huge funds available from the public till. On the other hand, the technicians of SCS—men without brass, in tan dungarees—are out on the broad fields, surveying terraces, laying out contours for furrowing or revegetation, finding waste-land locations for small reservoirs, driving grade stakes for the bulldozers. They know and talk the language of the farmer. They know what the farmer wants. They live close to the soil.

Their practicality is evidenced in such things as "drop inlets," which are placed about half-way up the inner sides of the detention reservoir's earthen dams. These constitute automatic draw-down tubes which go into action if and when a heavy downpour fills the upper part of the reservoir, usually about 65% called the "flood pool," permitting the water to flow down the creek in restrained volume so that it does not overflow its banks. The principle of draw-down is the same as that of the Miami Conservancy flood control dams in Ohio, which are equipped with flood gates to regulate the release of temporarily pent-up flood water, under what is called the "dry dam" system. This Miami district program was established after the disastrous Dayton flood of 1913.

The builders of the structures were well aware of the fallacy of the "multiple purpose" dam, and they placed plaques on all the dams carrying this inscription:

"The dams of the Miami Conservancy District are for flood prevention purposes. Their use for power development or for storage would be a menace to the cities below."

Like the Miami Conservancy dams, the small detention dams of SCS are predicated on the principle of the empty flood pool, with gradual release of excess water in case of exceptional and prolonged downpour. Being relatively small, it is usually found possible to locate them in steep "draws" or ravines, where rocky, rugged or scrubby land is utilized. Farmers as a rule are glad to give easements for such property, because the landowner is privileged to use the water for recreation, as a livestock supply, or for irrigation. Since the drainage area above the reservoir is protected by conservation practices, there is little if any siltation. The surface treatment is an essential part of the bargain. The total result when comparisons are made between the big- and little-dam programs is that in the average case the expense is greatly reduced.

Mill Creek, in southern Oklahoma, is a part of the total watershed that drains into Denison reservoir (Lake Texoma), built by the Army Engineers.

The SCS has given this creek subwatershed its typical treatment, including surface insoak, terraces, and small detention dams.

A typical dam in this system is positively engineered

to impound 5.22 inches of runoff. It is of cheap but substantial earthen construction, protected by Bermuda grass sod and equipped with drop inlet, spillway, etc.

The gigantic Denison dam, not far away, cost $61,-595,000. It contains 18,290,000 cubic yards, including concrete and steel, making the total cost $3.30 per cubic yard. The flood pool is 2,690,000 acre feet. The total watershed is 38,291 square miles. Using these factors we find that a net runoff of 1.31 inches would fill up the flood pool from lowest level and start running over the dam with the *same volume as though it were not there.*

Incidentally the cost of building the Mill Creek dam was only 27 cents per cubic yard. This is not the only basis for comparison, but it is enlightening. The main point is that the little dam is positively engineered to impound exactly four times as much water as the big dam, in proportion to its watershed area.

On top of this comparison we have the insoak coefficient produced by surface treatment. We have a draw-down tube which automatically prepares the little reservoir for the next big downpour—a feature that is not found in the Denison dam, where the public power interests and sportsmen demand that the flood pool be kept as full as possible, thereby subtracting from the impoundment capacity figure of 1.31 inches. Also we have an engineering calculation greatly favoring the little dam, furnished by an eminent hydraulic engineer, to be mentioned later.

Moving into another part of the Washita Valley of Oklahoma—theater of one of the most important of

the SCS demonstrations of agricultural flood control—we can consider the case of Little Washita Creek, a tributary of the main river near Chickasha.

The Chickasha Chamber of Commerce had asked for estimates from SCS and the Army Engineers as to a project for flood prevention. Hitherto it had been difficult to secure such comparisons, but comparative estimates were furnished by the respective agencies, and given during the course of a public Inter-Agency Committee meeting.

Assuming that this was not "classified" information, the writer used the table of deadly comparisons in an article in the *Country Gentleman* of May, 1952, reprinted in condensed form in the *Reader's Digest* for July, 1952. This publication evoked howls of anguish from the big-dammers, and the writer was honored with some ten pages of publicity in the printed report of the Committee on Public Works, House of Representatives, dated December 5, 1952. This committee, in its irate conclusion, recommended the complete abolition of the agricultural flood control program, which does not lend itself at all to the pork-barrel approach to the problem.

In the ten pages mentioned, the chief allegation was that the table was "inaccurate." It seems that the USDA for some reason had made minor revisions after that public hearing was held. The odd point in this contention is that the revised figures were even more favorable to the SCS method of flood control than the original ones. Yet the big-dam advocates seized upon it as an excuse for attacking the earlier magazine article. The general idea of the Army Engineer partisans must have

been to produce the vague impression among casual readers that the magazine statements were unreliable, in the hope that the readers would not understand the figures anyhow. Be that as it may, here are the figures of comparison *after revision.*

	Army Plan	*SCS Plan*
Number of reservoirs . . .	1	34
Drainage area, sq. mi. . . .	195	190
Flood Storage, acre feet . . .	52,000	59,108
Permanent pool, acres, (recreation)	1,950	2,082
Flood pool, acres	3,650	5,076
Bottoms inundated, acres . . .	1,850	1,464
Bottomlands protected . . .	3,371	8,080
Cost, proposed plan, estimated complete	$6,000,000	$1,973,307

It should be noted that inferior or waste land is used by the small SCS detention reservoirs, while the best and most fertile bottomland is inundated by the large reservoirs.

It should be remembered also, before leaving this table of telltale comparisons, that the single Army reservoir could do nothing toward stopping floods on the watershed above it, whereas the 34 small structures, with auxiliary surface treatment, would provide virtually perfect protection in the total pattern in which 75% to 85% of all agricultural flood damage is done on the tributary watershed.

Moreover, it should not be forgotten that the Army Engineers' money estimates are invariably smaller than the actual figures when the jobs are completed. As estab-

lished by Congressional inquiries, sometimes the final costs are found to be twice or even three or four times as large as the original estimates, so that the $6,000,000 figure easily might be considerably expanded.

Further information as to the SCS program in the Washita Valley will be given in Part III. It seems appropriate at this point to discuss another aspect of the indictment—the inundation of our most valuable farmlands.

A *cause célèbre* in the nation-wide controversy is that of the Blue Valley of Kansas, where the Army Engineers, taking the offensive, have used every possible stratagem to circumvent the virtually unanimous will of the farmers and home-owners of the critical area by actively promoting and actually beginning operations for the construction of the Tuttle Creek dam.

For a dozen years the Army Engineers planned complete and continuous inundation. When the controversy became acute, they announced that they might be able to change the specifications to those of a "dry dam," partially following the specifications of the Miami Conservancy District dams, though this would depart radically from the conventional structures of the Pick-Sloan program. This did not impress the farmers very much. They had analyzed all the specifications and because of the terrain, which is very different from that of the Miami, the seeming concession was nothing more than a gesture.

If completed, even as a "dry dam" project, this will inundate or render unfit for occupancy about 50,000 acres of rich, fertile bottomland, a Kansas garden spot

settled in the 1850's by hard-working, pious, loyal pioneers.

Included in the area to be flooded, permanently or sporadically, are several towns and villages; a large number of beautiful old stone farm homes, now equipped with modern conveniences; fine old churches; public schools; a children's home; several cemeteries (one of them containing 1,600 bodies) where loved ones are buried; an idyllic countryside dearly beloved by its people; many commercial establishments. The project was subjected to an emphatic referendum vote in the fall of 1952, when a Democratic Congressional candidate, Howard S. Miller, was elected in an unprecedented upset ballot, the district never having failed to elect a Republican before. The sole issue was the Tuttle Creek dam, and a normal Republican majority of 30,000 was changed to a Democratic majority of 3,800, for that reason alone.

The area annually produces farm crops worth $6,000-000. The project would dislocate the farm economy of the whole region, since certain crops are best suited to bottomlands and there is a reciprocal relationship, involving a kind of logistics between the valley dwellers and the neighboring upland farmers.

A board of top engineers, Abel Wolman, Louis R. Howson and N. T. Veatch, advised against the dam. Likewise the Missouri Basin Survey Commission gave an unfavorable report. The Kansas state legislature passed a resolution memorializing Congress and requesting the discontinuance of the project. Eminent engineers and hydraulic experts in Kansas advised against it. Neverthe-

less the Army Engineers defiantly pushed the project after a "rump session" of Congress sneaked through an authorization with only a small fraction of the legislators present.

If this big-dam project is consummated, it will disperse a homogeneous and large rural community as ruthlessly as was done in the case of Acadia. The destruction of the physical community could go down in the history of infamy as comparable to the wiping out of Lidice.

This is by no means an isolated case. Not far to the west of this area is the rich and fertile Solomon Valley, featured by a revered Indian shrine called Waconda Springs—one of the few Indian treasures left in the brash march of the white race. This is to be inundated along with vast areas of fertile farmland that is badly needed in our rapidly shrinking acreage, for Americans of the near future.

Revolt against expropriation of choice farmland, which will be acutely needed as the national population increases, is found in all parts of the nation.

One of the most energetic and effective campaigns of resistance has been made by the "Citizens Committee to Oppose the Mt. Upton Dam" of South New Berlin, N.Y.

This resulted in the compilation of the "Mt. Upton Impact Study," of July, 1952. Engineering studies were made, with excellent technical guidance, and a nine-point bill of particulars was filed with the Board of Engineers for Rivers and Harbors, Washington, D. C.

Among the points is the statement that the gross annual income loss to agriculture and other business in

this valley would be over three million dollars, or more than twice the Army Engineers' estimate.

Among the urgent recommendations is "that exploration of alternatives include consideration both of dams on smaller tributaries, where agriculture, industry and commerce would be less disturbed, and of run-off prevention on fields, pastures and woodlands throughout the watershed area."

This is one of many nation-wide expressions indicating that the agricultural flood control principle is not merely the "theory of a few cranks from Oklahoma."

In this same Oklahoma the big-dammers are desperately trying to put over the construction of huge reservoirs at Keystone, Markham's Ferry, Oologah, Eufaula and elsewhere, involving inundation of a total of more than 650,000 fertile acres. According to a survey made by Jo Ferguson, editor of the *Pawnee Chief,* the area that would be inundated by the Keystone project produces 40 percent of all the cattle currently received by the Tulsa stockyards. These are but random examples which show the perpetration of a national crime. The writer has received letters from widely scattered communities in New York, Missouri, Pennsylvania, Iowa, Minnesota, and other states showing the nation-wide scope of the program which, if consummated, will permanently remove millions of acres of our best and most fertile land from cultivation.

According to a brochure of Oklahoma A. & M. College, called *Your Three Acres* the nation now has only three acres per capita of productive farmland, and there

has been a rapid and substantial increase in population since the brochure was published. Two acres per capita is designated as the minimum requirement in a meat-based nutritional diet. It takes seven pounds of cereal protein to produce one pound of meat protein, so when we get down to two acres per capita we shall likely have to shift to rice, wheat, and other cereals, much as the people of Asia are compelled to do.

According to Dr. H. H. Bennett we are losing at least 400,000 acres of good farmland each year by erosion. The obvious conclusion is that we can't afford to lose the bottomlands. Every state or community that encourages or permits the inundation of large areas of bottomland is, in effect, inviting thousands of people to leave the state, since it is removing their economic and nutritional underpinning in proportion to the destruction of the land.

In various places in this book reference is made to our dwindling supply of good cropland. Lest these references seem to be inconsistent with the fact of chronic surpluses of certain "staple" farm crops, the following points need to be kept in mind.

Farm surpluses are caused by one or more of several factors:

1. Unwisely producing corn, cereals, and other mechanically handled "staple" cash crops on marginal or depleted land.
2. Foreign import competition.
3. Under-consumption with consequent malnutrition.
4. Shifting of the desire-demand of the people, for

instance the noticeably decreased use of wheat and other starchy foods, as of 1953.

5. Lack of the storage capacity which otherwise would enable farmers to wait out temporary market gluts by carry-over which would tend to even out the wide variables in crop years.

6. Uncertainties and variations in chemurgic (industrial conversion) uses of farm crops.

7. Producing "staple" crops under price supports on productive land that should be used for "vitamin crops." In the midst of the early 1930's, when the surplus problem was acute, the U. S. Department of Agriculture made the following amazing statement: "For every one to have a diet containing all the essential elements of nutrition which the USDA proposes, we would need, in excess of 1929 production: 108% more butter, 79% more fresh vegetables, 53% more milk, 43% more eggs, more meat, more citrus fruits, more of many other foods, and we would require 40 million extra acres beyond 1933 plantings, to grow all our needs." All of which goes to show that a complete understanding of the problem of putative farm surplus would have to extend over many years and include exploration of many angles.

In his last message to Congress in the summer of 1953 President Eisenhower said:

"In addition to the immediate danger of waste resulting from inadequate conservation measures, we must bear in mind the needs of a growing population and an expanding economy. At present we are faced

with excess reserves of some agricultural commodities and the need for production adjustments to gear our agricultural economy to current demands. But in the long run, we shall need to give increased attention to the improvement and reclamation of land in its broadest aspects, including soil productivity, irrigation, drainage, and the replenishing of ground-water reserves, if we are adequately to feed and clothe our people, to provide gainful employment, and to continue to improve our standard of living."

Incidentally, and in line with the theme of this book, it is noteworthy that President Eisenhower used for his principal theme the growing recognition on the part of land users and the public generally of the need to strengthen conservation in our upstream watersheds and to minimize flood damage. He urged that this policy should be adopted as an integral part of our total flood control and water use program.

As enlightened as this sounded, there was no clear-cut refutation of the perilous "main stem" theory of flood control.

The big dams still would hold their concrete thralldom of the land—if so, the President's otherwise thoughtful emphasis on upstream control largely would be wasted, for the land slowly would die, everywhere.

And, of all the ways the land dies in the blight area of the big dams, none is more tragic to watch, more bitter to behold than the death that comes in the soft horror of the silt, the piling, flowing silt that is formed of once-blooming topsoil and which is like a skeleton-secret in the closet so far as the dammers are concerned.

CHAPTER FIVE

Siltation and Backwater Sedimentation

Geologists have a saying—"The history of a lake is the history of its death."

Before weathering and siltation leveled off large areas, the primordial surface was speckled with millions of large and small lakes. Some still persist, particularly in areas where watersheds are well protected by rock, forest and vegetation, or when the bodies receive their supply from underground springs or porous underflow material rather than surface-flowing streams. In the prairie plowlands, with a dam thrown across a major stream, the life of a lake, geologically, is only the twinkling of an eye. Authoritative geologists say that the average artificial reservoir's life in such areas is about 50 years.

If you wish to visualize this really tremendous phenomenon, take a glass of water, stir into it a tablespoon-

ful or two of soil from your back yard, and see what happens.

While the fluid is in motion, it has a uniform consistency, but soon after it is allowed to become quiet, the heavier particles sink to the bottom. In many cases the water will be completely clear above the deposit after a few hours.

The classic example of fast fill-up with silt was seen in the water supply reservoir at Osborne, Kansas, which filled up in one year. In Oklahoma, Old Lake Altus filled up in 14 years. Excellent information on this subject will be found in the publication, No. 521, of the USDA, entitled *Sedimentation of Reservoirs.*

One of the mysteries of current discussions of a national soil and water policy by highly placed officials, politicians and engineers is that virtually no attention is paid to this exceedingly vital point, though it is obvious, even to the lay observer, that the millions of tons of sand accumulated in our river channels are a prime factor in floods.

Siltation, of course, is the direct result of erosion. The two phenomena are intimately joined.

About one-third of our nine-inch national average topsoil has been eroded—washed into gullies, streams, and oceans. That erosion is steadily going on. This wash is estimated at one cubic mile of solid matter annually, for the Mississippi River alone. Yet, to read the typical treatise on soil and water policy, you would think that this gigantic amount of silt calmly disappears after being washed from upland slopes.

Cleland's *Geology* gives the full story of the silt-

carrying capacity of stream flow, and what happens when velocity is increased. Taking the converse of the formula, we find that when a flow of water carries solid material, it drops large rocks when the current velocity is reduced below eight feet a second; when the velocity is reduced below twelve inches a second it drops gravel; when the velocity is reduced below six inches a second it drops fine sand. When the flow is stopped completely it finally drops the extremely fine rock particles.

Expressing the physical facts in common language, it is found that when muddy water strikes still water, due to an obstacle which prevents it from continuing in motion, the sediment is dropped to the bottom, as in the case of the glass of muddy water previously mentioned.

A prairie river like the Washita receives eroded soil according to a "rule-of-thumb" formula accepted by local hydraulic engineers. It receives two acre feet of solids per square mile of watershed per year. A calculation shows that the silt washed from an area like that of the Washita each year would make a pile 1,000 feet wide, 1,000 feet long and 700 feet high.

Obviously all this silt has to stop somewhere. There is a big dam downstream, and the water in the big reservoir is clear in the vicinity of the dam, showing that the deposit is made in the reservoir, or above it.

The place where the silt stops is fixed by immutable laws mentioned by Cleland, and the rate of flow, which determines the stopping place, is influenced by the scour-and-fill "habits" of the stream—that is, the ability of that stream to adapt itself by geological laws to the terrain. The "coefficient of roughness," having to

do with brush, roots, rocks or other channel obstacles, is one factor. Other factors are soil texture, gradient, intensity of storm areas, etc.

Cleland says: "Streams deposit their loads when they flow into lakes, forming deltas at their mouths and covering the bottom of the lake with the finer silt, which is carried farther out since it remains in suspension longer . . . It is thus seen that as soon as a lake comes into existence, agencies arise which tend to obliterate it."

Officials of USDA who say "we should also have big downstream dams" are invited to ponder this fact, and to re-read their own brochure 521.

In the lush blacklands of Illinois, where soybeans and corn necessitate the laying bare of rich soil that was once stabilized by sod, a large lake is disappearing. This is a geological process, though the phenomenon was caused wholly by man. Fact No. 1: He plowed. Fact No. 2: He built a dam.

Decatur is built on the banks of the historic Sangamon River. It wanted a lake for water supply, so it built a dam across the river, forming "Lake Decatur." The dam cost $2,013,000 in 1922.

Stretching fanwise above Decatur on the Sangamon watershed is an empire of rich, black soil. Because of the demands of chemurgy, with its plastics, oils and synthetics, soybeans have "taken the country," and Decatur is called the "soybean capital of the world." Soybean processing plants, a vital part of the community economy, were built to consume the product of the nearby fields.

For these plants the city needs 15,000,000 gallons of

water daily, so the lake is needed, not only for routine municipal water supply, but for the voracious industrial uses. The well-to-do have built cottages on the banks of the man-made lake and they enjoy boating and fishing (if any).

The Decatur Chamber of Commerce, in recent times, awoke to the fact that the lake was disappearing—not from mysterious earth convulsions, but because of the very simple fact that it was rapidly filling up with silt swiftly moving like black and brown paint off the exposed alluvial fan, on the loose in the watershed above the city. The lake water, for that reason, is never clear.

Four thousand tons of soil from each average farm each year; 500,000 tons annually from the watershed; a total of more than ten million tons in the brief lifetime of the artificial lake—that is the terrifying force at work, day and night, year after year, making land-soup.

The Chamber of Commerce foresaw the drying up of its industry. It employed two soil conservationists for the sole purpose of taking measures to stop that hemorrhage of the rich blacklands and the destruction of the once beautiful lake.

The writer visited this area in 1952 and found that valuable educational work was going on among the farmers, but not aggressively or fast enough to cure the bad situation. The final catastrophe would be postponed but not prevented.

Army Engineers had been called in for advice. All they could think of was to build two more big dams on the forked streams above the existing dam!

From here we might go to another place in the great valley.

Twenty-two farmers living in the bottoms of the Nemaha Creek, near the town of Kelly, Kansas, in 1952 brought suit against the state in an effort to recover damage that has been done to their farms by reason of the damming of that creek to produce a lake farther downstream.

Here we see more vividly the second phase of siltation, which is backwater sedimentation. First the silt is dropped at the mouth of the stream, where it enters the lake, then, by chain reaction, the slow-up of current with subsequent deposition, spreads like a blight, swiftly upstream. Rapidly, in one zone after another, the water is slowed down in accordance with the geological laws explained by Cleland. In the first place the stream determined its own pattern, according to those laws. When an obstacle is interposed, the stream begins all over again. Dr. H. H. Munger, professor of hydraulic engineering at Kansas State College, tells what happens in substantially these words:

"In the typical prairie valley of low gradient—but in exceptional cases even as much as one percent—the silt-laden stream tends to create a new bed parallel to the old bed at a height equal to the height of the dam, and this backwater sedimentation tends to continue indefinitely upstream and into the tributaries."

Since dams in the prairie plowlands are almost invariably much taller than the banks, upstream, it can readily be seen that the backwater sedimentation carries the probabilities of almost unimaginable and appalling

damage. It was the beginning of this kind of damage which brought the suit in Nemaha County, Kansas. Similar suits are imminent elsewhere. Up to this writing, 1954, the general public is virtually unaware of this enormous threat, even though premonitory evidences are becoming plentiful for those who know what it all means.

Even the Army Engineers have described this menace, though they certainly have made no effort to put this kind of research before the public. The writer has a blueprint, made by the Army Engineers, which forecasts ultimate backwater sedimentation on the Washita River to a point 100 river miles upstream from its mouth. However, the Munger formula would carry such damage indefinitely farther, and R. C. Longmire, president of the Washita Valley Council, who was born and reared on the banks of that river, declares that severe damage from this cause is already plainly evident at Pauls Valley, Oklahoma, 147 river miles upstream from the lake. He owns a farm on the banks and that farm is being badly cut up by the exaggerated meandering of the stream which occurs when its channel becomes clogged. The overall gradient from Lake Texoma to Pauls Valley averages five inches for each 1,000 feet.

We have case histories showing the effects of backwater sedimentation above Grand Lake, Oklahoma, above Lake Overholser, near Oklahoma City, in the Waurika area on Beaver Creek (tributary of the Red River), on the Rio Grande, and elsewhere. Photographs eloquently show what has happened.

In the summer of 1951 there were six floods that in-

undated the town of Waurika. Such a thing had never happened before.

Accompanied by Mr. Longmire, the writer toured the area after the last flood of the rainy season, and we plainly saw what had happened.

First we visited Red River where it is crossed by U. S. Highway 77 and the Santa Fe Railroad, south of Thackerville, Oklahoma. This area is about six miles from where the Red River widens to become Lake Texoma, artificially formed by Denison dam.

Huge banks of sand were photographed from the bridge, both up and down stream. Local residents said that the sandy bed of the river at the Santa Fe bridge was twelve feet higher than it was before the reservoir was built, approximately ten years before.

We then traveled westward, skirting the river, seeing a continuation of silt deposits. At the town of Ryan, about 100 river miles upstream from the (Red) rivermouth, we were taken to the mouth of Beaver Creek by J. T. Daniel, editor of the local newspaper. Here we saw an extraordinary sight. The creek, at its mouth, was about 100 feet wide, while the water channel of Red River, flanked by vast sand banks, was only about half that width. Beyond that narrow strip of water, southward, for about half a mile across to the Texas side, and stretching as far as the eye could reach, were millions of tons of sand, backed up in what used to be the bed of Red River. Mr. Daniel remarked that these beds had increased considerably in recent years. According to Dr. Irving Perrine, geologist and a long-time Oklahoma resident, these sand beds had been deposited partially

before the big dam was built, but had grown greatly since that time.

We then drove northerly along Beaver Creek, about a dozen miles, to Waurika. Here we found that the flood plain had received a heavy and unprecedented deposit of silt during the floods, caused by a slow-up of the creek, contrary to its previous habits. Old-timers said they couldn't understand why the flooded creek ran so much more slowly than it had before. A farmer named Hensley, living in the bottoms, showed us a fence post which had become so nearly submerged by silt during the summer of 1951 that only a few inches protruded above ground. "This all happened during the 1951 floods," he said.

The whole phenomenon then became plain. When an unusually heavy rain came, the water pouring down Beaver Creek struck the bottleneck at its mouth—the heavy sand-banks in the river—and backed up into the town and the intervening flood plain of the valley.

A short time before this inspection of the Red River–Waurika situation the writer visited the upper part of Grand Lake (Pensacola reservoir) which was constructed almost coincidentally with Texoma Lake, by damming the Grand River (called Neosho in Kansas) in eastern Oklahoma.

The Neosho headwaters reach into the region deluged by the great Kansas flood of 1951. Yet the city of Miami, a short distance above the mouth of the river, at the head of Grand Lake, had the worst flood in its history, one which did $5,000,000 worth of damage and drowned a man.

President Truman and Gen. Lewis A. Pick flew over the flooded area during that critical period. They saw the water from a considerable height, but they did not see the mud.

In the area called "Twin Bridges," where U. S. Highway 60 crosses the confluence of the Neosho and Spring rivers, at the upper end of Grand Lake, the writer slogged around in that mud, which had recently arrived from Kansas cornfields, taking photographs, one of which shows an old blacktop pavement freshly covered with at least two inches of it. We talked with a young farmer along the river above this point, and he said thousands of tons of mud had been left on the flood plain by that one inundation, and he had to use a bulldozer to clear away the worst of it around the house and farm buildings. "I wish I had a dollar for every ton of it," he wistfully lamented.

The writer also took photographs of mud banks already showing above the surface of the water near Twin Bridges. About a year later, after a long drouth, a photographer in a plane took amazing pictures of the same area, showing the vast beds of silt that had been deposited since the construction of the reservoir.

What President Truman and Gen. Pick did not see or know as they flew high above the area was that the Miami flood was *caused* largely by the presence of the huge Pensacola dam. Long after the flood, the Army Engineers reluctantly admitted that 18 feet of silt had been deposited in three places in the old river bed.

The circumstantial evidence alone, however, would have been convincing. According to the report of the

Army Engineers during the worst of the disaster, the flood stage at Miami was 778.52 feet above sea level at the same time it was 755 feet at the dam. This meant a slope of 23.52 feet down the few miles of river and the surface of the lake. The writer learned from the testimony that nearly all of this slope occurred between Twin Bridges and the dam at the foot of the lake, the flood stage at the bridges being almost up to that of Miami. There was a hump, therefore the incongruous slope.

The total and momentous conclusion, reinforced by later air photographs, is that already—after about 14 years of the dam's life—there is a tremendous accumulation of silt at or below the mouth of the river, forming a secondary or hidden dam, and that is what caused the bottleneck and put a peak on the unprecedented Miami flood. In fact it would be strange if such a process of deltation had not occurred, since it is according to strict natural law.

The same pattern is seen at the mouth of the Washita River at Lake Texoma. Here we found a farmer preparing to bring suit against the federal government because the backwater sedimentation from Lake Texoma had brought increasing flooding of his land and the choking out of alfalfa and other valuable crops, so that much of his otherwise fertile land had grown up to Johnson grass and weeds.

The people at Madill and Tishomingo, near the Washita River arm of Lake Texoma, had hailed the coming of the reservoir about ten years before, in the belief that they were sitting on the edge of a great potential

recreation area, a sportsman's paradise. However, they have become bitterly disillusioned, for the mouth of the river has been filled up with silt to a depth of 20 feet since the building of the dam; their bay is muddy far out into the lake; areas that once had deep water are now shallow; the silt has choked out vegetation upon which aquatic life ultimately depends; the federal fish hatchery director in the neighborhood had said that Lake Texoma fishing was ultimately doomed because of sedimentation. The Madill and Tishomingo people recently held mass meetings to see what they could do, but found that they could do nothing except to hope and pray that the Washita Valley Agricultural Flood Control Program of SCS would be completed, so silt would quit flowing down the river.

At the 1953 meeting of the Oklahoma State Association of Soil Conservation Districts, Raymond Gary, president pro tem of the state Senate, brought loud cheers from an audience of 500 leading farmers from all over Oklahoma, when he said, in substance:

"We can see now what has happened to the Washita. The channel is filled up with silt. Instead of building big dams we ought to spend the money on agricultural watershed treatment." Senator Gary lives at Madill, virtually on the banks of the lake. Like the others who had anticipated the big recreational project, he has been disillusioned.

A frightening and monstrous case of backwater sedimentation is seen in the Rio Grande above Elephant Butte reservoir, New Mexico. Arthur Carhart, in his excellent book, *Water—or Your Life* (pages 201-204),

gives the specifications, which cannot be ignored by any sincere advocate of intelligent water management.

Space requirements forbid an extended recital. One could fill a book with equally convincing case histories of past and continuing damage caused by existing dams, but the important point is that similar damage from the same cause is planned for the future.

One of the biggest dams promoted by the Army Engineers for Oklahoma is the one planned for Eufaula, near the junction of the North and South Canadian rivers.

Refreshingly frank was Col. E. G. Daly, then head of the state division of the Corps, when, in a speech at Stigler, Okla., October 17, 1949, he said: "This dam is definitely intended as a silt trap." He furthermore said that its usefulness would be over in about fifty years—a calculation which is generally shared by eminent geologists as a fair average life of reservoirs for the plowland states.

Since the Eufaula dam is estimated to cost $139,450,000 Col. Daly's remark is especially significant. That sum of money looks like quite a lot of cash for the American taxpayers to spend, just to cover up more than 100,000 acres of fertile bottomland with sterile sand, ironically assuming that such a dismal thing is desired.

The frank confession concerning this project may cause the taxpayer to wonder whether most of the Pick-Sloan Plan series will not turn out to be a grandiose system of silt-traps—not only useless in the long run, but far worse than useless because of the upstream chain reaction which wrecks land above the reservoirs

—even larger acreage than is embraced in the areas to be inundated. The series of huge dams is still only a few minutes old, geologically. When it gets to be two, three or four decades old (by the calendar), the American people will see what they have bought for the $57,000,000,000 which the Pick-Sloan promoters in 1948 announced as the overall goal.

For a few minutes it may be profitable in this connection to look into some of the spending habits of the Army Engineers, which were frankly discussed in a feature article in the St. Louis *Post Dispatch,* August 20, 1951, and roundly excoriated in an editorial next day.

The *Post Dispatch,* strange as it may seem, is not an enemy of big dams. It champions the MVA system of big dams. That makes its observations all the more significant.

The story concerns the report of a House Appropriations subcommittee, headed by Rep. John H. Kerr of North Carolina, a doughty warrior who repeatedly has taken up the cudgels on this same score.

"A horrible example of misplanning" was charged by the report against the Engineers.

"Current cost estimates for 182 river and harbor flood control projects now under construction by the engineers are $3,273,933,000 higher than they were when Congress authorized them," said the story, "noting a jump from an original total of $2,638,517,000 to the current $5,912,451,000. That increase is 124 percent. Much of the boost is due to higher prices, but

30.6 percent of it, or $800,000,000 represents 'insufficient engineering planning and estimating' in the committee's opinion."

"One unidentified project (produces) a cost of 4839 percent more than estimates," the story continues. "In the case of Fort Randall, at least 30 percent of the $122,300,000 cost increase was due to bad planning." There was an increase in cost of $74,750,000 in the Fort Peck dam and $163,000,000 increase in the Garrison project. These are specimens in the scandalous equation. One pertinent point made by the committee was that if Congress had known in advance what the actual costs would be, it might not have approved the projects."

The more painful truth is that if Congress had known all the other facts about the point-by-point unsoundness of the whole big-dam program, it would never have listened to any of the promotional talk. (Assuming, of course, that Congress wishes to act in the best interests of the American people.)

Does Congress know that the big prairie reservoirs are destined to be short-lived sand catchers? Or does it stick its collective head in the sand and pretend the danger is not there?

In the year 2053, if the Pick-Sloan Plan is fulfilled and the $57,000,000,000 (to which at least 124 percent will be added if current indications hold good) of the people's money is spent, what will we have for our money—say $100,000,000,000 or more? What will be the nature of this grandiose monument to the ingenuity and defiant persistence of the Army Engineers

and their counterparts in the Bureau of Reclamation?

Unless nature miraculously reverses her present laws, the learning of geology is proved to be false, silt no longer drops to the bottom in quiet water, and streams run backward up the slope into the mountains, this is what the people of the year 2053 will see:

Up and down every major stream in the low-gradient farmlands of the nation there will be giant step-like terraces. The lower vertical face of each terrace will be an artificial concrete wall, from 100 to 200 feet high and from half a mile to five miles long. Above this wall will be an almost level plain of sterile sand extending up the valley from the top of the concrete wall to the zone where the river once entered the extinct lake. Down the face of this flat, almost level terrain will meander a sluggish stream, and since it will be no longer restrained, it will respond to every heavy rain by deserting its fitful channel and wandering crazily all over the flatland, so none of the land can be dependably cultivated, even if it were fertile.

"Why would the sand flat be sterile?" someone may ask.

Because muddy flood water consists considerably of light humus and soluble minerals which do not settle to the bottom of the reservoir when the storm churns the water. The light humus and minerals—the fertile parts—go on over the dam while the heavier rock particles, sand, gravel and stones sink to the bottom and finally form the permanent flatland, constituting another step for "Deserts on the March."

On the concrete walls there will be plaques, no doubt,

showing that these grandiose structures are a monument to the genius of Army Engineers and pork-hungry politicians and Reclamation Bureau officials.

If this sounds fanciful, read the substance of a conversation the writer had with another high-ranking Army Engineer, a predecessor of Col. Daly in Oklahoma. Here are the questions and answers:

"The Mannford [now called Keystone] dam will be subject to rapid siltation, won't it, Colonel?"

"Yes, I would say so."

"How soon will it fill up?"

"Oh, maybe about 50 years."

"What will be done when this fills up?"

"Well, we'll just move upstream, find another location and build another dam."

CHAPTER SIX

Drying-out Basins

The problem of where to store water is, unfortunately, one which has an obvious answer. And, throughout the world, men have chosen exactly that answer, following a sort of path of least resistance. The answer is surface reservoirs, big and little, but all committed to the proposition, roughly, that a puddle of water in sight is better than a vast store of water out of sight. For, actually, reservoirs are just that, puddles, when compared to the vast reaches of nature's own water storage system in the porous rocks of the earth. Perhaps there is something reassuring about being able to look directly at your water supply in a reservoir. There is nothing at all reassuring, however, about a square, honest look at what happens to that supply thanks to an inherent weakness of the surface reservoir system. Here is an example:

Oklahoma City was having a severe water shortage as this chapter was written—in the summer of 1953.

In this rapidly growing community it is impossible to set down a figure of normal water consumption, but during the year it has often been 25,000,000 gallons a day.

"When the weather is hot and windy, as it has been recently, our two reservoirs lose 25,000,000 gallons a day by evaporation," said Morrison B. Cunningham, superintendent of the water department of the city government.

The contemporary scene involved the voting of bonds for the drilling of 80 wells near the city, to tap the underground water storage that is found in a natural bed of sand along the North Canadian River. These wells, it was estimated, would furnish at least 22,000,000 gallons a day, assuming that the water table did not go down materially. They would be fairly shallow, being replenished by the "underflow" sand in the river bottoms.

Water taken from wells doesn't evaporate. It is placed directly in the mains and covered reservoirs for immediate consumption.

Of course, it is realized that not every community has the natural underground storage or supply that is found here, but undoubtedly it would be possible greatly to enlarge the present resources of this character.

Geologists can soon determine the potentials of this type of storage.

The National Water Policy Panel of the Engineers' Joint Council—presumably the most authoritative body of its kind in the nation—takes cognizance of this problem in a brochure, issued in 1951. It says that

underground storage is preferable to surface storage, wherever practicable.

Modern engineers are now utilizing porous geological structures for storage of natural gas and oil. Why should we overlook the possibilities of similar water storage?

It is safe to say that during the next fifty years the science of such storage will become one of the most important factors in the national water policy. The studies have been spurred by the realization that the national water table is dropping, with the further fact that surface storage is tremendously wasteful, from the factor of evaporation alone.

So far as the writer has been able to ascertain, there is no detailed tabulation of the total underground storage capacity of the nation. Not all the requisite soundings have been made. Such soundings would necessarily have to be painstaking and expensive, covering virtually every square mile of the nation's land surface, except for rugged rock terrain. However, there are enough rough indices to indicate that the capacity is prodigious—far greater than all the surface reservoirs, built or projected.

Dr. Robert C. Cook, director of the Population Reference Bureau, of Washington, makes these observations:

"The United States may run seriously short of water in the next half century.

"Some 4.3 trillion gallons of water fall as rain each day on this vast country. About 3 trillion gallons immediately evaporate into the atmosphere, to come as rain

another day. The remaining 1.3 trillion gallons would furnish the average flow for about three Mississippis. This is more than enough water for everybody.

"But if these trillion gallons were to run unchecked down the hills into streams and rivers the land would be quickly gutted, floods would take over the rivers, and river bottoms would be buried in silt. Surface-water sources would be rendered unfit for use and the ground-water reservoir would shrink. There would be muddy water everywhere, but not a drop fit to drink.

"The capacity of our ground-water reservoir is enormous. The greatest reserve of surface water is the Great Lakes. They contain about two-and-a-half years of the total rainfall of the entire nation, less evaporation. Yet before extensive pumping began the ground reserve contained more water than the Great Lakes.

"Now the mining of this ground water has reached the danger point in some parts of the United States. In the high-plains region of Southern Texas, for example, water is being drawn from the ground at twenty times the rate of replacement. Depletion of ground water has jeopardized the operation of industrial plants in the Ohio Valley. It is resulting in the seeping of sea water into wells on Long Island and other places along the Eastern seaboard."

Whether this ground-water reserve can be kept high enough to meet the needs of a rapidly growing population, Dr. Cook says, depends on how farms are tilled and how adequately the ground cover of forests and grasslands is maintained.

"Until a century ago," he says, "primeval forests

maintained the ground-water reserves of the United States at a high level. But to the pioneer the forest was an enemy to be destroyed. This pioneer attitude persists today, as witness what happens when a bulldozer moves into a forest area to open a subdivision."

When the silt-gathering tendencies of the surface reservoirs are considered, the contrast between surface and underground storage becomes all the more impressive.

To replenish the ground-water supply, it is necessary to have watershed-wide absorption. A multitude of small reservoirs can go a long way in this direction. Far more extensive absorption, however, is achieved by terracing, revegetation, contour furrowing and related practices. The big reservoirs, despite their bigness, can cover only an extremely small fraction of the watershed, so they can hardly be considered valuable in this respect.

In some localities, notably in California, considerable success has been achieved in areas of exceptionally porous surface material, however, by building "spreader" dams for the express purpose of ground-water recharge.

Since 1935 there have been successful demonstrations of recharge of ground waters, particularly on Long Island, which have been described in the technical journals and books. These have no specific significance in connection with agriculture, since they are chiefly a phase of urban industrial installations but, nevertheless, they do teach a most valuable lesson. They teach that man, if he will, can go a long way toward maintaining and preserving ground-water supplies. The method

whereby agriculture fits into this picture is described in another chapter.

Those who are concerned with a national water policy should pay more attention to the gross inefficiency of the surface reservoir, an inefficiency due largely to evaporation.

Dr. William Clifford Morse, State Geologist and Director of the Mississippi Geological Survey, in an address to the Mississippi Society of Professional Engineers, in mid-February, 1954, said:

"Ground water can be conserved if there be ground water to conserve and there can be ground water if Nature be allowed to function . . . It can be traced back to rainfall, to all types of precipitation. . . . Man has no control over the rate of precipitation. But he has great power over obstruction to surface flow. Herein lies his power—the power to leave the vegetable covering as God made it to hold back the flow of surface water, so it has time to soak into the ground as ground water . . . Man has much to do with the porosity of the soil by means of deep cultivation and by plowing under vegetable matter." He endorsed the major conservation practices, mentioned elsewhere in this book, as prime means of producing insoak.

The four major low-level downstream reservoirs in Oklahoma—Grand, Texoma, Tenkiller and Fort Gibson—have a total area of 171,000 acres. If we apply the Oklahoma City factor of 25,000,000 gallons evaporation per day on the 4,200 acres of the two Oklahoma City water supply reservoirs, we get approximately one

billion gallons or 30,000,000 barrels of evaporation loss a day. This, of course, is only a fraction of the total dead storage, but it gives a rough idea of the enormous amount of water that is wasted, so far as crop production is concerned, by letting the water run down the land surface into the huge low-level reservoirs.

At this writing there is a proposal that Oklahoma City and other central or western cities secure more water by pumping some of this reservoir water back up-hill—a distance of around 200 miles and a vertical lift up to 900 feet, utilizing open canals, pipe and pumping-stations. However, almost coincidentally, Dr. W. H. Irwin of Oklahoma A. & M. College issued a statement asserting that each year enough water falls on Oklahoma to last all of its industries 50 years. According to Water Superintendent Morrison B. Cunningham of Oklahoma (president of the National Waterworks Association at this writing), the average annual flow in the North and South Canadian rivers past Oklahoma City is about 600,000 acre feet, or about 200 billion gallons. Putting these various facts together we can easily see the value of stopping water where it falls, in the ways indicated by Dr. Morse.

We can remember, too, that it may well be the water we can't see, soaked into *natural* reservoirs, that will preserve the precious liquid asset we can't afford to waste.

CHAPTER SEVEN

The Multiple-purpose Delusion

As though realizing that single arguments in favor of big dams scarcely can hold water, the dam planners have come up with a combination, super-special, bargain-offer, dazzler of a new excuse for lacing the land with concrete. This new shibboleth, a real gem, is "multiple purpose." Now, instead of building dams only for a single purpose, they can be built for a bunch. Instead of one peril they can offer multiple perils—and paradoxes. The "multiple purpose" of a reservoir to control floods and store water is an obvious example which, although appallingly plain in its absurdity, is terribly persistent in its ability to attract champions.

If a reservoir is to have flood control functions, it must contain the runoff from the watershed to an extent great enough to accommodate the intense downpours usually called cloudbursts, ranging up to 10 or even 15 inches falling within a typically severe storm period—say two or three days.

Copious impoundment (storage) obviously is the one and only function of value in any reservoir, big or small, so far as any flood control function is concerned.

If a reservoir lacks large impoundment capacity, it fails, to the extent of that lack, in controlling floods.

A full reservoir, or one nearly full, therefore, is useless to the degree that it already contains water. Only an empty reservoir or one nearly empty can be said to be efficient in flood control.

There are a few—very few—large and efficient flood control reservoirs in the United States. They are sometimes called "dry dams." They have gates to release water at a safe rate after every heavy downpour. Thus the reservoir is made ready for the next storm by being emptied or made nearly empty. They can be used in certain types of terrain where inundation of valuable farmland is not a factor.

The best examples are found in the zone of the Miami River basin of Ohio in which Dayton suffered so greatly from the catastrophic flood of 1913. A description of these dams was given in Chapter 4.

Nobody has ever questioned the scientific validity of the formula that the use of a flood control dam for storage constitutes a menace to the zone below the reservoir, as carefully stipulated in the building of these structures, yet there is a continuous and extremely costly effort to repudiate this basic principle in the building of huge dams in the prairie plowlands. They are called "multiple purpose" dams, which means they are, figuratively and almost literally, trying to carry water on both shoulders in a vain effort to placate two diametrically

opposite schools of thought and simultaneously achieve two diametrically opposite objectives.

The ideal flood control reservoir, as we have said, is the empty one. The ideal reservoir for power or for storage, including municipal water supply, irrigation, and recreation, of course, is a full one.

The politically minded flood control leaders, following the well-known political formula of being "all things to all men," have devised a phantom reservoir which has theoretically three or possibly four different "pools," one on top of the other.

The lower part of the reservoir is called the "permanent pool." In an effort to counteract the growing public consciousness of rapid siltation, this is sometimes subdivided so that a conveniently (and theoretically) small space is reserved for the holding of sediment. This deceives no one who has given scientific study to the rapid progress of siltation, but it may quiet some of the uneasy but uncritical onlookers who don't know how silt behaves.

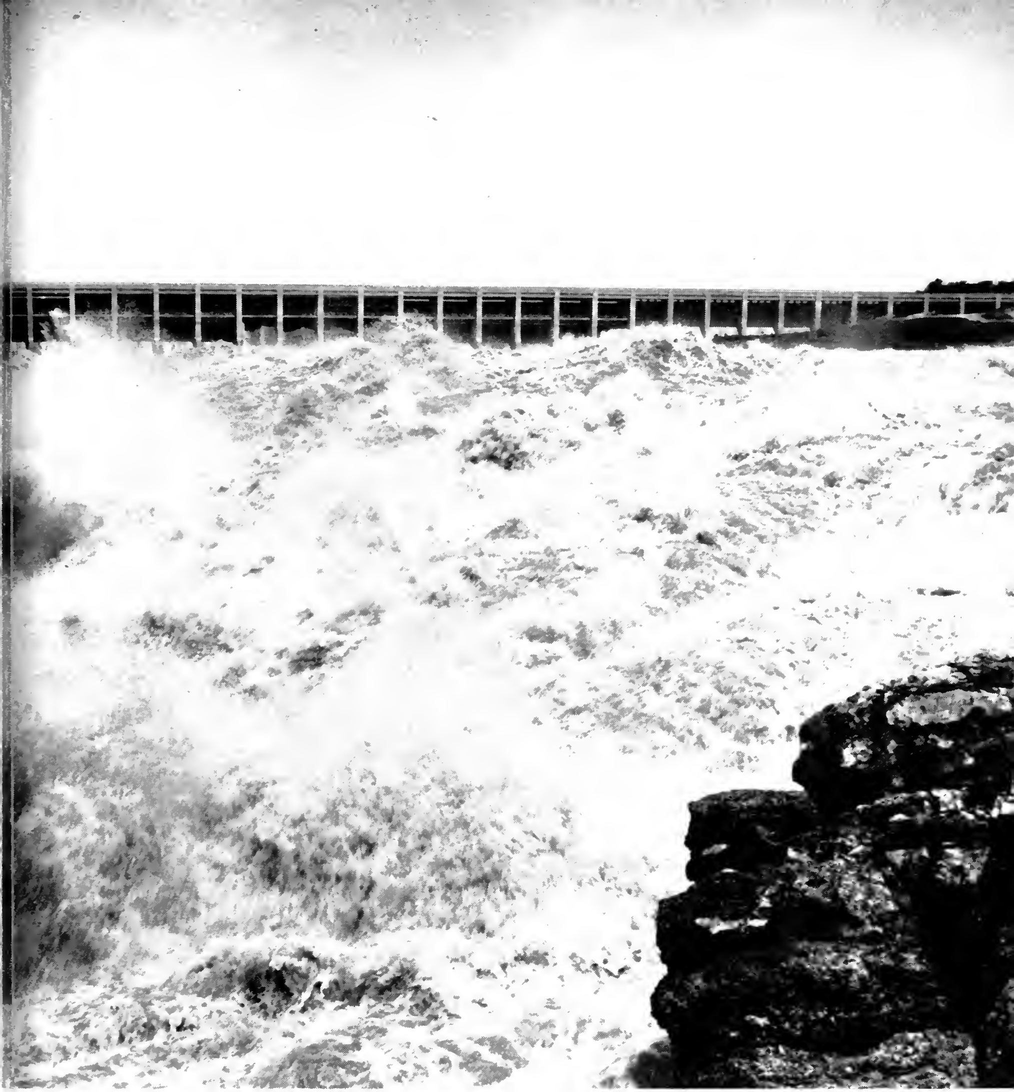
Next, usually, is the theoretical "power pool," representing volume that can be drawn upon to produce hydroelectric energy. The top layer is called the "flood pool." Theoretically it should be kept low—down to the surface of the "power pool." In actual practice, however, public opinion and the pressure of sportsmen and the public power interests dictate that the level be kept high, preferably up to the spillway plane. Otherwise, the boat docks would be up on a shelf, there would be bare, muddy, and ugly slopes just above the water's edge, and the people would be unhappy about mosqui-

toes on mud flats, the nasty smell of slowly drying slime in the hot sun and the impossibility of maintaining attractive landing places. The power interests like to keep the water level high—even above the power pool—to avoid the probability of running short of water to produce power in the long drouths that occur in the prairie plowlands. In fact such a shortage occurred in Grand Lake, Oklahoma, in 1943. Ironically this was the very same year that the lake had overflowed and produced half of the worst flood that visited the Arkansas River in the memory of living citizens.

It is well to remind the reader again that the Grand Lake (Pensacola) reservoir failed to hold flood waters to the extent that it overflowed with disastrous consequences below the dam, in 1943, 1950 and 1951. Three times in eight years.

Previous to the big May flood, the water level had been kept high because the politically vested interests wanted to make a showing of hydro power to satisfy public demand. So when the flood came it contributed substantially to the Arkansas flood, downstream, which cost 19 lives and did $127,000,000 worth of damage. Grand River furnished the top half of this Arkansas River flood. That was what did the damage, for if the dam had actually contained the Grand River flood according to the glittering prospectus and oratory, there would have been only high water (no flood of consequence) in the Arkansas River.

Assuming that a large reservoir is divided into three approximately equal layers or "pools," it means that each of the three principal functions is reduced to one-



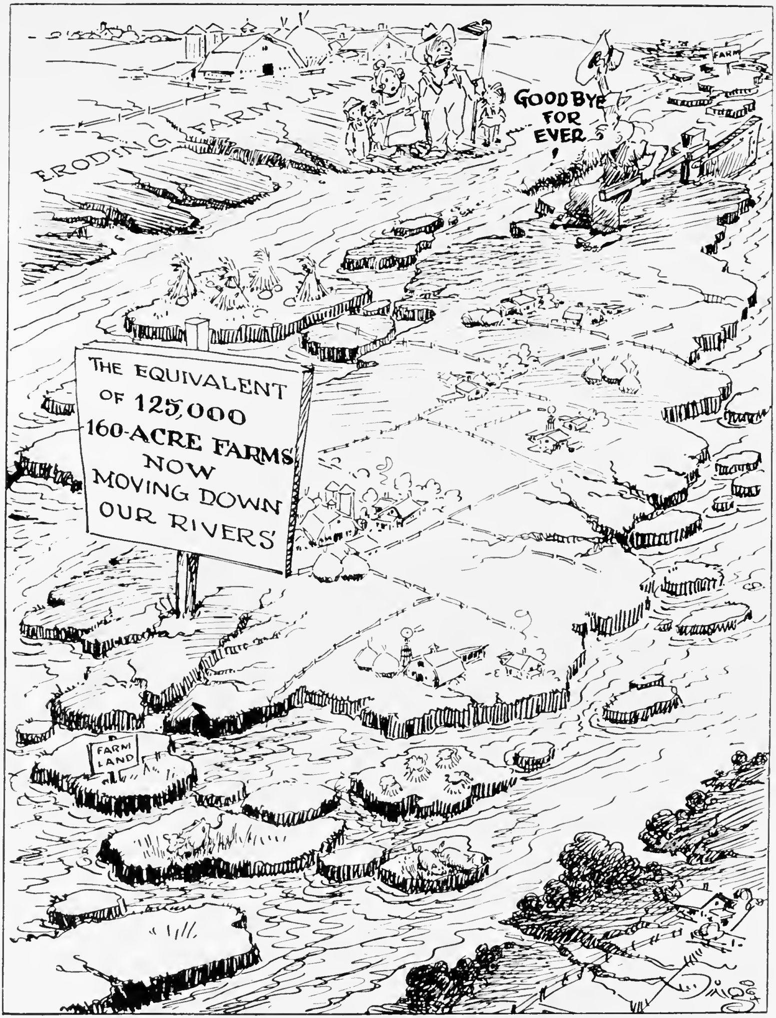
Pensacola (Grand Lake) dam, Grand River, Oklahoma. Photo taken in spring of 1951, when the dam spilled over in great volume through its gates, showing lack of impounding capacity following a Kansas flood. Photographer was told rate was 200,000 cubic feet per second.

Exposed banks of silt near head of Grand Lake, Oklahoma. Aerial photo shows tributaries with overbank (bottoms) heavily covered with deposit. This is analogous to creation of deltas at the mouths of the Mississippi and the Nile. *(Photo by Delmer L. Curtis, Aerial Photo Service.)*

Opposite: Watershed flood control in action. This is Structure No. 17 of the Sandstone Creek, Oklahoma watershed, tributary to the Washita River, in operation May 1, 1954, after a cloudburst of 3.30 inches falling within 60 to 90 minutes on April 29. This downpour followed one of about 3 inches falling two days before, making a total of more than 6 inches. This reservoir impounds runoff from 6340 acres, releasing it gradually into the "main stem" at a rate that prevents flooding.

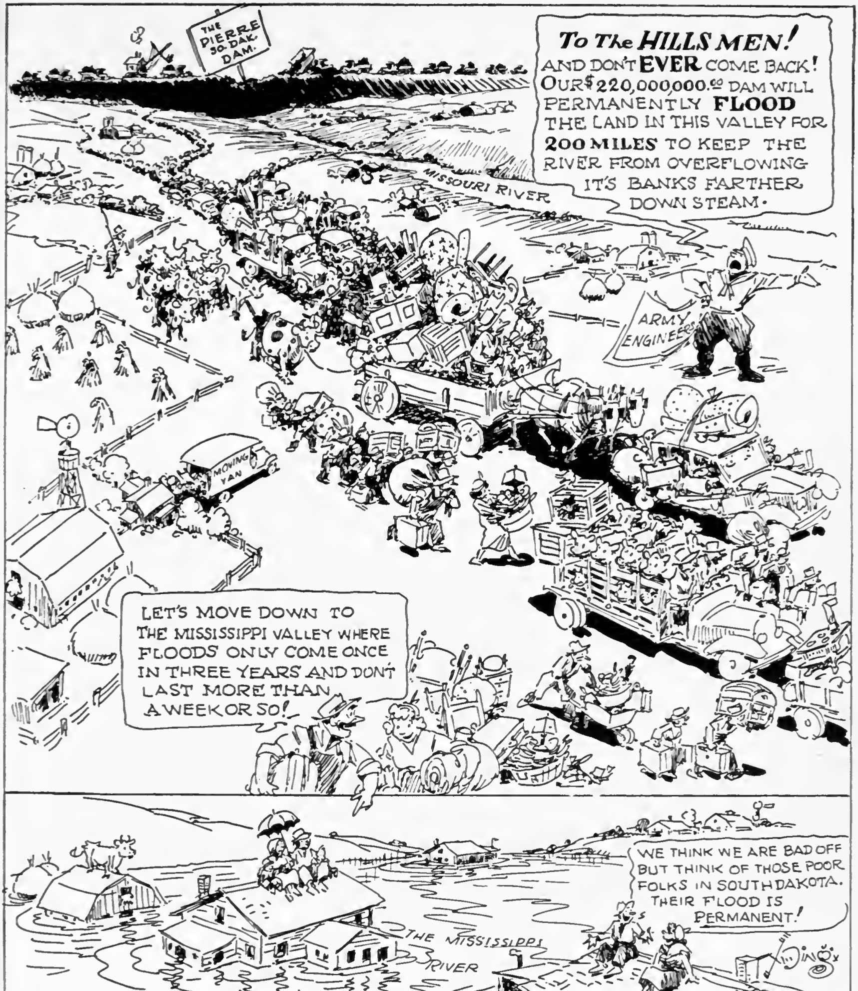
The drawdown provided by a "drop inlet" is seen gradually emptying the part of impounded volume called the "flood pool." This device automatically effects uniform discharge, spread out over several days in case of a super-flood, so the old creek channel below the dam cannot overflow its banks nor contribute excess flow to the main channels down-

(continued)
stream. In this instance none of the 24 Sandstone Creek flood pools was filled to more than a small fraction of capacity. The reduction of discharge was so effective that the Washita River "main stem" was able to carry from adjacent creek watersheds (not yet given the SCS treatment) a flood from a ten-inch cloudburst which was dissipated before it reached the Mountain View sector, not far below. In contrast to this performance was the situation of April 3–4, 1934, before the SCS program was started, when a 14-inch cloudburst hit the Sandstone area. The 1934 deluge covered only half the area of that of the 1954 cloudburst, so the latter was greater; yet the 1934 deluge drowned 17 persons and did tremendous damage down the Washita. Thus it was demonstrated that a creek watershed does operate to control floods "on the main stem," so the "do-not-claim" formula is shown to be absurd. The total watershed area of the Washita River is more than 5,000,000 acres, compared with less than 100,000 acres in the Sandstone Creek project, so this performance is all the more remarkable. With this and other rapidly accumulating evidence, advocates of watershed flood control contend that if the whole 5,000,000 acres were treated with SCS methods there would be no flood possible on the "main stem," even under super-flood conditions. The Sandstone Creek area provides the hardest possible test of the insoak-and-detention-dam method, since it is subject to extremes of drouth and deluge, and heavy vegetative growth is inhibited. *(Photo by* USDA-SCS.*)*



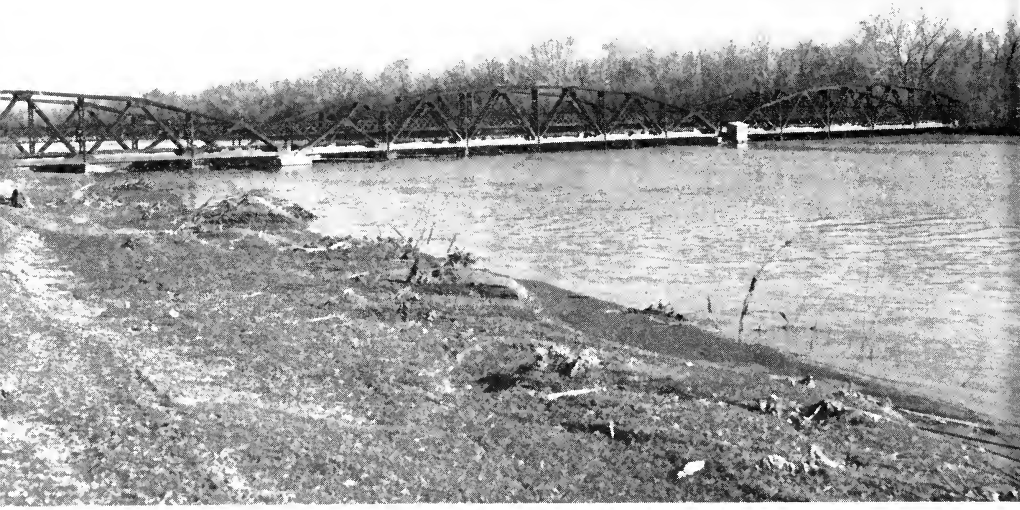
WHAT THAT MUD IN OUR RIVER
ADDS UP TO EACH YEAR

(Drawing by Jay N. Darling)



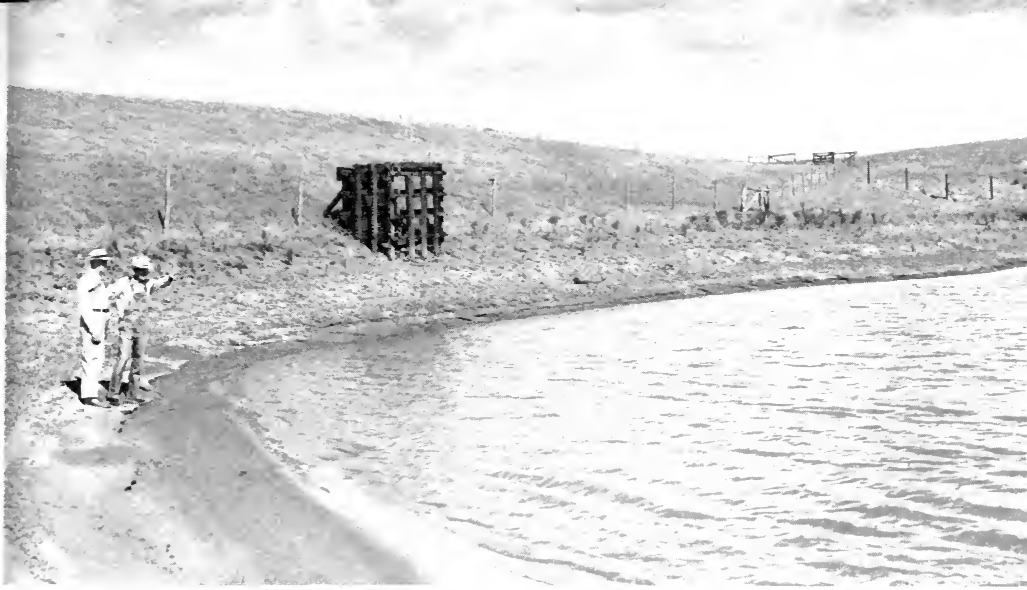
FLOODING PETER TO SAVE PAUL

(Drawing by Jay N. Darling)



Highway bridge across Rio Grande River, near San Marcial, New Mexico, in summer 1952. Washout of the bridge is imminent and is due to backwater sedimentation caused by Elephant Butte dam below. *(Photo by C. E. Redman.)*

Dr. Hugh H. Bennett *(left),* then chief of the U.S. Soil Conservation Service, and the author near Webbers Falls, Oklahoma, in May 1943. Photo was taken after the disastrous Arkansas River flood, of which one half flowed over from the Pensacola (Grand Lake) dam because of inadequate impoundment. The other half came down the Arkansas River from above its confluence with Grand River. The picture shows the deep, sterile, crop-destroying silt dropped by floods. *(Photo by J. W. Hammett,* USDA-SCS.*)*



Small detention dam of USDA-SCS watershed flood-prevention program, Upper Barnitz Creek, near Clinton, Oklahoma. Next to insoak, this is the best alternative to big dams. Jess Dewees, pioneer watershed-program advocate, is showing the author where the water comes from. The crib on the side of the dam, to the left, is the "drop inlet" or "drawdown tube" mentioned elsewhere in the book. *(Photo by Jacoby, courtesy* THE COUNTRY GENTLEMAN.*)*

Detention dam of the SCS watershed flood-control program, Herberg Ranch, Brady, Texas. *(Photo by* USDA-SCS.*)*

Terracing, contour furrowing, and strip cropping in Lockhart, Texas. Photo shows how the Soil Conservation Service watershed program stops the water where it falls and produces insoak. Were it not for this treatment, the water would flow rapidly down the slope and cause or augment floods. *(Photo by* USDA-SCS.*)*

third of the potency it ought to have, plus the fact that one objective works diametrically against another objective, tending to cancel it out altogether. Certainly the actual history of the Grand Lake fiasco substantiates this criticism.

It seems appropriate to interpolate a brief passage from the introduction to a study of multiple-purpose reservoirs in the 1950 Transactions of the American Society of Civil Engineers.

This notes the fact that in 1945 a joint committee on design and operation of such structures was sponsored by the Hydraulics Division of the Society to study and report on the problems involved. A distinguished committee was appointed. Concerning their labors, the introduction remarked:

"It was very quickly found by the committee that there were no fixed principles upon which the design and operation of multiple-purpose reservoir systems could be based; nor was there even any agreement as to what constituted a multiple-purpose reservoir. . . . So marked were the differences between the inchoate philosophies of those responsible for design and operation of multiple-purpose reservoirs that the committee felt it should obtain public expression and discussion of such divergent views. A number of papers were therefore solicited from representatives of most of the federal agencies concerned and from others affected by such projects." It was related further that such papers were provided by the Army Engineers, Bureau of Reclamation, TVA, and other agencies.

These agencies are notably sensitive to the demands

of Congress and the bureaucracy, so it is natural to conclude that politics play a large part in the final determination.

One thing the lay public is likely to overlook is that engineers, like many other scientists, will undertake almost any problem if employed or commissioned to do so, even though a given project may be impracticable. This is to their credit, for such research has untold value in itself. For instance the late Joseph B. Strauss, designer of the Golden Gate Bridge, told the writer that his graduation thesis was on the subject of a bridge across Bering Strait, a distance of 36 miles. If commissioned to pass upon practicability, they will do so, but the fact that they may finally come up with a space-ship or a multiple-purpose dam is not necessarily a testament of practicability or economic validity.

They may justifiably say to the politicians: "If you want a multiple-purpose dam, we will do our best to design one." But it is easy to read between the lines of the ironical introduction the implications of the "inchoate philosophies."

Now, back to the specific case.

While discussing Grand Lake it is well to consider that it is a significant part of a region that can well serve as a laboratory demonstration of the "*reductio ad absurdum*" of the big-dam system, in which the big-dammers run hog-wild. The rest of the nation ought to profit by the example.

Grand River (called the Neosho at Miami and from there up into Kansas) enters Oklahoma a short distance north of Miami, and normally flows southerly until it

reaches the Arkansas River, east of Muskogee, near Fort Gibson.

Pensacola dam was completed in 1940, the water backing up nearly to Miami. Fort Gibson dam, a few miles from the confluence of the Grand River with the Arkansas, was completed in 1950. The Army Engineers' program calls for the construction of a third dam, at Markham's Ferry, which, if completed, will produce virtually a solid chain of three lakes from Miami to Fort Gibson, so it may be said that practically the entire Grand River Valley, under that name, will be inundated and abolished.

In 1943, after the severe flood, Col. F. J. Wilson, then head of the Army Engineers in Oklahoma, made a report which said:

> The three-reservoir system proposed by the War Department as described in House Document No. 107, 76th Congress, First Session, dated January 12, 1939, consists of Pensacola (Grand Lake) reservoir. . . . Markham Ferry reservoir and Fort Gibson reservoir. . . . With the three-reservoir system, as planned by the War Department, it would have been possible to equalize the total flow on the Grand River so that 266,000 cubic feet a second could have been taken off the flood crest at Muskogee.

The context of his statement goes to show that the flood pool capacity of Pensacola (Grand Lake) reservoir was not sufficient to meet the demands of a major storm such as that which hit the area in May, 1943. He further criticized the Grand River Dam Authority for keeping the flood pool high, saying, "the conflict be-

tween the requirement of full reservoirs for power and empty reservoirs for flood control should be eliminated in the public interest." The full context of his statement argues that the ideal flood control situation, from the Army Engineers' standpoint, cannot be achieved without having a solid series of reservoirs end to end. Like dropping a pebble in a pool, the building of one dam ripples along to another, then others—to the end.

CHAPTER EIGHT

Big Dams and Socialized Power

Just as the big dams attempt to take God's physical world and remake it according to the unreasonable whims of man, they attempt, ultimately, to change man's political world. They must do this, by their very nature. They must cut across all individual and local rights, to stretch their fingers wherever the engineers would have them. They must operate under an exclusive and excluding system of economics because they would be a paradox in an orthodox one. As a result of these and other facts, big dams, just as surely as the donkey is the symbol of Democrats and the elephant the symbol of Republicans, could be the focal symbol of all those different intellectual wanderers of our time whose invariable destination seems to be total socialism.

This economic-philosophic aspect of big dams generally has been conveniently obscured behind the flying, dramatic spray that billows from the flumes or spillways in the slick dam propaganda movies.

Actually, however, those two aspects are fundamental to the situation. Just how fundamental may come as a shock to many readers.

A significant brochure called *Encroaching Socialism* was compiled a few years ago by Charles W. Battley, and it clearly demonstrates the chain of circumstances which led to the establishment of the Tennessee Valley Authority—a project which was promoted as the first of a series of similar valley authorities which would eventually cover the entire country. By photostats and other unquestioned evidence Battley shows that the grandiose scheme was hatched, shortly after the first of the century, by the Socialist party, whose leaders realized and pointed out that whoever controls power will eventually control industry. Prominent advocates of TVA attempt to laugh off the Socialist origin, but they may as well try to allege that the Socialist platforms of those early years of the century were not really socialistic. The Socialist party sponsorship of the valley authority program is as authentic as the key utterances of Karl Marx. In 1920, in the Congress of Soviets, Lenin made a chief issue of hydroelectric power, saying the electrification was essential to the successful operation of Socialism. "The Soviets plus electrification, produce Socialism," he said. But this is only one of countless items of evidence.

The Missouri Valley Authority, like the proposed Columbia River Authority and similar projects, will follow the TVA pattern, which sets up an authoritarian government-within-a-government, to build huge dams and hydro power plants, and exercise control over a

vast array of industrial and commercial activities. It includes flood control in its objectives, along with navigation, but a major objective is hydroelectric energy generation, whereby the federal government may take over large areas of power production now occupied by private enterprise. Some of the phases of TVA are slightly out of the province of this book, which is aimed at the prairie plowland regions, but since MVA and other valley authorities are on the agenda, the TVA experience is significant and should be considered.

One important phase of the TVA program is the inundation of valuable farmlands.

W. V. Howard, a farmer and geologist living at Dover, Tenn., appeared before the U. S. Senate Public Works Committee in March, 1948, and let go a fusillade of facts and figures which startled the lone member present, but somehow failed to get into the newspapers.

He was president of the Lower Cumberland Association, which opposed the building of high dams on the Cumberland because of the flooding of fertile lands of that zone.

Howard testified that when the Kentucky dam was built, it flooded 300,000 acres of rich bottomlands which had been producing foodstuffs at the rate of $21,000,000 annually.

TVA boasts that the hydro power house of this dam produces electric energy worth $3,000,000 annually, or one-seventh of the value of the farm crops.

(Mr. Howard mentioned one minor but significant item to the effect that TVA built the Harriman coal terminal at a cost of about $250,000 and now leases it to

the Arrow Transportation Co. of Sheffield, Ala., for one dollar a year.)

An important disclosure was that TVA annually enters on its books amounts totaling more than $2,000,000 as the expense of operating navigation facilities, but this seems to be purely a "book-keeping item," since the work is actually done by the Army Engineers. For the fiscal year that cost was $433,648.52, and it was paid from Army (public treasury) funds.

In the annual report of TVA for 1946, TVA entered the sum of $149,116,375 as its investment in navigation facilities.

Funds to make this investment possible were advanced by the Treasury Department. TVA pays no interest to the Treasury Department. The taxpayers pay it, just as they pay interest on all Treasury borrowings. The taxpayers subsidized TVA shipping to the extent of $6,855,997 in the fiscal year 1946, which includes the last half of 1945, and in that calendar year shipping on the river totaled 256,465,000 ton miles. This figures out to a subsidy of 2.65 cents per ton mile, which is approximately three times what it would have cost to have shipped the goods by rail. The foregoing figures are taken from official government records.

There are many more calculations, cited by Howard, who concludes that navigation on the TVA system is a "washout"—that TVA's own statements confirm the contention that TVA navigation is not worth more than a fraction of its cost. Statistics of the Army Engineers point to the conclusion that the future holds no hope for river navigation on the Tennessee.

One factor in the hopelessness is that 60 percent of the river tonnage, according to the best obtainable figures, consists of government business, which is figured into the total as if it were commercial traffic. Of this government traffic, 25 percent represents broken rock and similar material used for riprapping lake banks, and 35 percent represents coal for a steam plant which takes the place of hydro energy in the TVA power picture.

This government coal haulage may increase, unless the managers decide to use the cheaper rail transport, because some enormous steam plants are being built in the TVA area, since hydro power has been found to be more expensive and less dependable. These steam plants will cost at least three-quarters of a billion dollars, and they will produce socialized power to compete with private enterprise. The hydro power played false during one of the critical war years, and TVA had to buy electric energy from privately owned steam plants to firm up its delivery of energy for vital war industry.

These are but scattering evidences of the mythical and elusive nature of TVA—a project which was first based on the quasi-mystical worship of "white coal" and the notion that a great and cheaply produced natural force was being unleashed for the benefit of the whole people.

An impressive thesis can be written to show that cheap electricity helps the people of the immediate region, but no one pretends that it helps the forty-odd million American families who pay the bill so that a relatively small splinter of the taxpayers may enjoy the

blessings of electric lights, washers, refrigerators, deep freeze outfits, and waffle-irons.

Fulton Lewis, Jr., radio commentator, on March 29-30, 1954, discussed more recent aspects of the TVA program, referring especially to the effort of some Congressmen to require TVA to pay annual interest on its investment, thus placing it more nearly on a basis of equality and reasonable competition with private enterprise. Following are some of his more incisive comments:

"Flood control was the least of the interest of the original inceptors of the project, and their real interest was the generation and sale of the power. They wanted to get the government into a nationalized power industry . . . The TVA's own statistics show that the amount it has invested thus far in flood control projects amounts to $340,000,000, whereas the amount it has invested in the incidentals, the surplus activities such as power, a chemical plant and other lesser projects, comes to over one billion, one hundred million. So the tail, very decidedly, is wagging the dog. This, I'm sure, sounds very ridiculous and silly to you, but I assure you that these are the actual statistics from the TVA Annual Report itself. . . . In its annual report TVA claims to show for 1953, for example, a net operating surplus or profit of $19,000,000. And to the casual inspector . . . this is very impressive . . . But what TVA forgets to show . . . is that there is a little item of one hundred million dollars which it fails to pay in federal, state and other taxes, and which it fails to pay in interest on the money the federal government has invested

. . . which has to be made up by the public at large, over the nation. When you take that figure into consideration, it means, simply, that instead of making a net profit of $19,000,000 for last year, the TVA had a net operating loss of a hundred and one million, minus 19 million, or 82 million dollars. . . ."

Before dismissing the subject of socialized power it should be noted that a highly praiseworthy institution called the Rural Electrification Administration has become dominated by the public power interests, with weird results.

In the summer of 1952 some of the highly placed officials of REA appeared at Congressional hearings, alleging that they represented millions of farmers desiring REA service, and upon this filmy pretext they demanded that big dams be built for power, ostensibly so that REA might have more hydro energy for the farmers.

Nothing could be more plausible—that is, if you take everything at its face value. Obviously they had been in touch with the big-dam promoters and had been coached in strategy.

There are gaping holes in their presentation.

In the first place it should be well understood that REA, as originally established, was a fine, worthy program in that it provided for the distribution of electric energy to farmers, bought wholesale from private enterprise. It still is a fine, worthy program to the extent that it follows that pattern.

In the early days of REA it was expressly forbidden that REA go into the power-generating business itself

in towns of more than 1,500 population, for that would obviously be one long step toward the socialization of industry. Various REA officials, however, cynically and brazenly started violating the law, and now Congress, under the pressure of force by other officials, has authorized the building of power plants in various places.

The hypocrisy of this maneuver is seen in the fact that these REA officials are not actually planning hydroelectric plants of their own, but instead they do promote steam plants to serve REA. It has been demonstrated beyond any doubt that electric energy can now be produced—in all localities of low-gradient streams and reasonably priced coal and natural gas—cheaper by steam than by hydro installations. That is why the big steam plants are planned for the very heart of TVA. So it happens that the big multiple-purpose reservoir for the prairie plowlands is promoted as a phantom leverage to pry appropriations out of Congress and to scare Senators and Representatives who know that the big dam is obsolete and inefficient. This surrender to a pressure block, not actually representing the farmers but really operating against them, is one of the political factors appearing in the Washington theater.

In an address before the Case Institute of Technology, April 11, 1953, former President Hoover, a great engineer and a great patriot, discussed the federal socialization of electric power. Here are excerpts from his address:

"The device by which our federal bureaucracy started to socialize this (power) industry was through the electric power from our multiple purpose water conserva-

tion dams . . . Twenty years ago the total generating capacity of electric power from federal dams was about 300,000 horsepower. It was about 2/3 of 1% of the total electric generating capacity at that time . . . By the middle of 1953, the federal government will have a generating capacity of about 15,000,000 horsepower. That is about 12% of the utility generating capacity for sale to the public. Federal power is already being sent into 27 states. But far beyond this, there are federal generating plants in construction or authorized by Congress, making a total of over 200 plants which will bring the total up to about 37,000,000 horsepower. If completed the federal government would be furnishing somewhere from 20% to 25% of the electric utility capacity of the nation. The cost in capital outlay to the taxpayer will be about 10 to 11 billions, plus some great deficits in promised interest and other returns . . . Some part of the heavy taxes on private utilities goes to build up and support their federal competitors . . . These federal enterprises and their distributing allies pay no taxes to the federal government and comparatively little to the local governments. In the last fiscal year the private enterprise utilities paid over $750,000,000 in taxes to the federal government and nearly $470,000,000 to the state and local governments. Obviously there is here a huge burden thrust onto every taxpayer. It will be much greater if the 37,000,000 horsepower program is completed. Nor is this all of the burdens thrust upon the nation-wide taxpayer.

"In many cases the cost of constructing these projects has been woefully underestimated. For instance

the Colorado–Big Thompson project was originally estimated at about $44,000,000, but is costing over $160,000,000. The Hungry Horse [what an appropriate name!—E.T.P.] project, originally estimated at about $39,000,000, is costing about $109,000,000. Work has been started on the Oahe project. It was originally estimated to cost about $72,000,000. It is now estimated that it will cost $293,000,000."

Mr. Hoover's speech described many other undesirable features of federal control of electric power, all of which add up to the fact of socialistic encroachment on and ultimate destruction of private industry.

As the result of what Ray Tucker of the McClure Syndicate, in the *Oklahoma City Times,* describes as the "high-handed tactics" of the Army Engineer Corps, which he calls "the most powerful and free-spending lobby on Capitol Hill," the House of Representatives gave the Corps a "stunning reverse" in June, 1953.

This came about in the study of the Garrison dam of western North Dakota. Here are verbatim excerpts from Mr. Tucker's story:

"The uproar came when the Army Engineers, allegedly without congressional authorization, decided to raise the height of the dam from 1830 to 1950 feet. Again without legal authority or funds, they began to buy up farm lands to be flooded by the enlarged Garrison reservoir. . . .

"Their annual 'pork barrel' is the most popular piece of legislation defying all attempts at economy. . . .

"But both the military and the complacent politicians had reckoned without Rep. Usher L. Burdick, 73, Wil-

liston. A member of the non-partisan league, this Indian-speaking historian of the Sioux tribe and former Big Ten football star is one of the most respected members of the lower body. The pioneer of the plains charged [that] their unauthorized revision would drown out three existing irrigation systems and an additional 90,000 acres. It would also deprive Williston, bustling center of a vast new oil boom in the surrounding region, of all railroad connections. 'The military enters a farmer's house while he and his family are at supper,' according to local complaints. 'They announce: "We have condemned your land. You'll have to sell it to us, but we'll let you rent it from us until you get in this year's crops. Then you'll have to get out."' "

Though farmers bear the worst brunt of such high-handed expropriations, they are informed that "big dams are essential to the REA program, therefore farmers should be in favor of it."

One of the strangest angles in all this complex picture is that you will occasionally find "dollar socialists" playing important parts. They are infrequent and short-sightedly selfish public utility retailers of power, who antagonize the long-range welfare of their own private enterprise system by whooping it up for big federal power dams. That is because they happen to be in position to buy federal power wholesale at a lower rate than they can produce it themselves or buy it from private wholesalers. Then they sell it at a profit. Naturally this is confusing to the lay public, which is not familiar with all the "wheels within wheels."

The real issue, notwithstanding the complexities,

stands out, stark and grim. It is the certainty that growing federal power operations, whether by steam or hydro plant, furnish the line of least resistance to the ambitious politicians who are trying to change our system to a socialist state, many of them without even knowing the basic meanings and techniques of socialism, but knowing only the materialist lure of "changing the world."

CHAPTER NINE

The Atom Pitches Two Strikes

Flooding of cities and countryside by gradually rising torrents from rainfall or snow-thaw is tragedy, but the sudden bursting of a giant dam is a hundredfold cataclysm.

The Johnstown (Pa.) flood of May 31, 1889, is ranked with great earthquakes, volcanic eruptions, and terrible hurricanes of history, yet the south fork of the Conemaugh, containing the reservoir, is a minor stream. The enormity of the disaster came from the suddenness of the collapse of the dam across this little river, which snuffed out more than 2,000 lives (the exact number was never known) and caused $10,000,000 in property loss. This disaster evoked national and international sympathy, and widespread contributions for relief.

In this atomic age, when by comparison a small package of properly activated and processed uranium can make ordinary two-ton bombs look like firecrackers, every large dam above a populated district is a poten-

tial death sentence which may be executed easily and without warning. It is a sitting duck.

Certainly there is no phenomenon of destruction in which it can be so truly said that "time is of the essence." The people living below the dam would not even receive the warning of heavy rains, such as occurred before the Johnstown disaster. The bomb would necessarily strike like unexpected lightning out of a relatively clear sky, since surprise is an accepted military "must."

It must not be assumed that such a peril is imaginary or theoretical. Destruction of big dams in war-time has arrived at the stage of standard practice.

The story of the demolition of the great Möhne, Sorpe, and Eder dams in Germany by the British Royal Air Force has become almost a classic of World War II.

The operation involved intensive study of hydraulics and other engineering sciences. The blasts were timed so the shocks produced by separate mines would be cumulative—piling one terrific concussion on top of another.

On the chosen day the air force attacked and severely damaged these three reservoirs, releasing at least three-fourths of the impounded water and causing the most destructive floods on record in the Ruhr Valley, and along the Rhine River below Duisburg-Ruhrort. Several 1,500-pound mines were dropped against the upper side of the dams, the airmen flying about 100 feet above the earth. Together the Möhne and Sorpe dams controlled almost three-quarters of the Ruhr River watershed and about two-thirds of the water storage in the industrial area of the Ruhr. The Eder dam controlled the flow of the Weser River. There was enormous loss of life, as

testified by a group of German editors with whom the writer visited several years later.

On May 5, 1944, an Allied air force bombed the control gates of a dam on the Pescara River in Italy, flooding German positions on the Adriatic and doing vast damage.

Our potential enemy, Russia, has already tested out the technique and efficiency of dam-bombing.

In 1941, pursuing the "scorched-earth" policy, the Russians blew up the great Dnieprostroy dam, in an effort to halt the German advance. The dam was 110 feet high and 2,500 feet long and had been completed in 1932, under the direction of American engineers.

The tremendous magnifying of explosive power made possible by atomic fission, to replace TNT or other familiar explosives, makes the presence of dams a greater war-time menace than ever. There would be no necessity for the unique cumulative technique, calculated and accomplished by the RAF in Germany. One atomic bomb, even if it were not set off in contact with the dam, could do the job because of the incompressibility of water.

The death-dealing nature of the explosion as such would be only a part of the menace, for the water, rushing from the broken dam, would be instantly contaminated by radio-activity from which there could be no escape.

To obtain professional information on this point, the writer consulted authorities of the University of Oklahoma, and his letter was answered by George W. Reid, associate professor of civil engineering, April 15, 1953.

The letter mainly was in technical language, but the requested information was contained in this statement:

"Surface water supplies can be contaminated by atomic fall-out, neutron-induced activity, or by radiological warfare agents."

Imagine what would happen if the Tuttle Creek dam were built in Kansas and some enemy nation should decide upon a surprise attack.

With the suddenness of an avalanche the water would pour down into the Kansas River in the Manhattan sector, wiping out most of the city and spreading radioactivity upon whatever remained. Then it would quickly get down to Topeka, Lawrence, and Kansas City, repeating the assault.

Grand Coulee, Bonneville and Hoover dams would be natural prime targets. Downstream communities could be wiped out in the twinkling of an eye and survivors, if any, would be attacked by the deadly rays. Great power plants would be destroyed and dependent cities would be instantly paralyzed and deprived of potable water.

The TVA series, of course, would provide wide-open targets, with consequences in proportion to the size and importance of the reservoirs.

Dams planned by the Army Engineers for the Shenandoah and other tributaries of the Potomac would pour their deadly poison into the nation's capital, together with unprecedented floods and destruction of electric power supply.

Certainly no enemy could wish for a more convenient method of wiping out whole populations, creating in-

stant water famine and destruction of industrial potential, and crippling the fighting power of a nation than to have huge made-to-order dams poised over vital cities, like magnifications of the fabled "sword of Damocles," inviting attack by atom bombs.

Dr. Harold H. Munger, professor of hydraulic engineering at Kansas State College, says all huge reservoirs in the prairie region are "booby traps" in this modern age, because of the vastly increased facilities for destroying them in the twinkling of an eye and releasing their terrific force upon the people and their institutions far down the valley below. The same thing is true, proportionately, with respect to levees and all other structures that hold large bodies of water suspended over the heads of the people.

That constitutes one strike on the American people, pitched by atomic energy.

The second strike, with constructive aspect, consists in the fact that atomic energy now promises to become a major form of power. As this book is written, the cost is higher than that of other common forms, but there is every reason to believe that the ingenuity of scientists will overcome this handicap, so that we may visualize, say for the year 1965, a feasible and economical form of atomic power that will crowd out the others.

When this happens of course it will render the great hydro plants of the nation obsolete, and deprive the big-dam builders of another plausible selling point.

Thus, coming and going, you could say, the atom is a nemesis of the big dams. And the big dams, in the newest sense of all, become the nemesis of us all.

CHAPTER TEN

How About Mountain Streams?

This book is aimed at the huge silt-catching structures of the low-gradient streams in the plowlands.

Though the writer has been in every state in the Union, lived in California and at this writing has a son at Boise, Idaho, a companion on pleasant mountain fishing trips, he does not claim familiarity with the problem as it applies to the clear mountain streams of high-gradient and protected watersheds, except to say that Arrow Rock reservoir near Boise seems to be amply justified. It receives practically silt-free water, and the sharp gradient makes it possible to have a large, deep reservoir with an extremely variable shoreline, the like of which can be valuable for flood control if the seasons are fairly regular and the lake is made empty—or nearly so—before the next rainy season. Such a reservoir might have value for power if that variable level did not interfere. There are so many technical aspects that

no comment will be made except to say that there is no more similarity between Arrow Rock and the proposed Tuttle Creek lake in Kansas than there is between an elephant and a goldfish. The big-dam promoters seem to have blandly and blindly assumed that if a large reservoir is desirable in the mountains, it is also desirable in the silt-washing and silt-clogged channels of flatland streams.

It is appropriate, nevertheless, to mention a few considerations as presented by experts in the mountain regions. Such appraisals may furnish a cause for doubt.

The adverse opinions of W. V. Howard of Tennessee regarding TVA have been quoted. Arthur Hawthorne Carhart of Denver, in an article in *Sports Afield* for March, 1952, calls the Colorado–Big Thompson project a "Pattern for Murder." This fantastic adventure, frequently called the "Rube Goldberg Scheme," because of its complex bootstrap-lifting philosophy, is roundly denounced by Carhart who declares, among other things, that its operation has ruined trout-fishing (one of Colorado's greatest assets) for a long distance, that the irrigation phase is a joke, and that the power angle is a fraud. Former President Hoover, in a previous chapter, is quoted on the exorbitant cost of the project. To get the Rube Goldberg angle, it may be well to explain that the overall scheme is to dam the Colorado River and raise the water in Grand Lake so that it overflows into a 13-mile tunnel through the Great Divide, into power turbines which generate energy which is sent back through the tunnel to the Grand Lake side, where it lifts water from another reservoir into Grand Lake. At the Atlantic

side, near Estes Park—where the turbines are located—the water flows into the Big Thompson, with the purpose of augmenting it and producing additional water from the Pacific slope to water crops on the Atlantic slope.

One of the favorite gasping-spots in the United States is Grand Coulee dam, which is so large that it had to be cooled artificially while the concrete was being poured—the heating of solidifying concrete in large masses being a phase of such construction.

The project had been completed several years when this book was written, but only recently have the practical details of the dream emerged.

The project was chiefly promoted as an irrigation venture, and it cost $553,000,000. Irrigated crops were first raised in 1952, and at this writing the immigrants numbered 300 families. Ultimately the planners expect to have 13,000 new farms on the desert, supporting 80,000 people, but that is conjecture. Ultimately a million acres of desert land will be irrigated, the promoters say. At best that would figure out at $553 an acre if irrigation is the chief objective. The climate is trying, since it varies from 33 below zero to 113 above. If farmers in the humid belt were to receive $553 or even down to $100 an acre, it would sumptuously set them up in business where there is not such a fight with the thermometer. Inasmuch as we are annually losing several hundred thousands of acres of land in the humid belt because of erosion, it would seem to be wiser to spend a fraction of that sum on conservation methods according to the

Washita Valley method, to be discussed in detail later on.

The most stupendous project yet proposed is that of the Central Arizona program, which would take water from the Colorado River, pump it 985 feet vertically and then run it out onto the arid desert, to add still further to cash crop surpluses at a cost of nearly two thousand dollars per acre. If you are interested in any of these projects, write to the Bureau of Reclamation, U. S. Department of the Interior, for details.

Conservation leaders, almost unanimously, are alarmed at the Bureau of Reclamation's project to build the Echo Park and Split Mountain dams in the Dinosaur National Monument, in Utah and Colorado.

A tremendous amount of propaganda material has been written and circulated for and against this project. From the standpoint of engineering techniques, the need for irrigation water and related aspects, the writer is unable to form a judgment on his own motion, except to observe that an increasing amount of discount has to be levied against hydroelectric power, which is rapidly tending to become obsolete, due to the imminence of the atom and other factors mentioned elsewhere in this book. Hydro power is an asset claimed for the project.

However, the testimony of the opponents is impressive, including vigorous statements by Gen. U. S. Grant III, an authority in this field, the Izaak Walton League of America, Sierra Club, Federation of Western Outdoor Clubs, National Wildlife Federation, Wildlife Man-

agement Institute, National Parks Association, The Wilderness Society, National Audubon Society, Nature Conservancy, National Council of State Garden Clubs, Sports Afield, Outdoor Writers Association of America, League of Ohio Sportsmen, Central Ohio Anglers and Hunters Club, and the New York State Conservation Council.

The least that can be said is that this area belongs to the American people as a whole, and not to selfish special interests who would like to exploit it, and certainly no action should be taken until the people have had a chance to study the project and give their opinions.

One more angle of the mountain area big dam promotion appears in the form of resolutions adopted by the Associated Sportsmen of California, Inc., regarding the proposed Trinity Division by the U. S. Bureau of Reclamation, February 7, 1952.

The resolutions are obviously drawn up by expert technicians. There is no need for verbatim quotations, but the gist of the resolutions is a pronouncement advocating a multitude of small dams instead of the huge structures like that of Shasta dam. "Many small upstream reservoirs in this Central Valley" are urged by this body.

This is in line with the urgent recommendations of Courtlandt Eaton of Colorado, a hydraulic and dam-building engineer of long and illustrious record, as may be seen by his biographical sketch in the book, *Who's Who in Engineering*.

When Bonneville dam on the lower Columbia River was first promoted, its boosters proclaimed that it would

have great value as a flood control structure. In 1948 such a vast torrent of water tumbled over this "multiple purpose" structure that it caused a great catastrophe at Vanport, drowning 40 persons and doing $200,000,-000 worth of damage.

In the June, 1952, issue of *American Forests* is an emphatic and convincing condemnation of the big-dam policy as it relates to both basin lands and mountain areas. Following are excerpts:

"(A Southern lumber company) is faced with the loss of 60,000 acres of its best timber-growing land. It may be forced to shut down much of its milling facilities. Federal government authorities say the land is needed as a reservoir site for a flood control dam . . . A government dam planned for the Angelina River in East Texas would take 200,000 acres out of production. Most of it is forest land . . . Permanently flooded, this land would never again produce a sawlog or a stick of pulpwood . . . On the Kootenai River in Montana the government is planning a dam that will back water at a distance of 98 miles . . . Although substantial forest areas will be flooded, the project will have greater adverse effects by hampering access to some 700,000 acres of virgin public and private timber . . . The virtually completed Hungry Horse is the world's third highest concrete dam. When its reservoir is full it will cover 35 square miles of the Flathead Valley . . . Some 22,000 acres of the most productive timberland in the Flathead National Forest will be under water." Other instances, on the Columbia River and elsewhere, are described. A picture shows the use of a gigantic suspended steel ball,

eight feet in diameter, used to clear timber simply by knocking it down—without even realizing its lumber value. The article concludes: "Dams swallow the good land. The law of gravity inevitably locates them where water can be impounded—at the floor of the valley. That's where the best soils are found."

So the juggernaut moves on—into the most beautiful and productive vales of our nation, smashing down beautiful and valuable trees, demolishing homes, desecrating burial grounds of loved ones, drowning some of the choicest values of the good earth.

PART III

THE AGRICULTURAL FLOOD CONTROL SOLUTION

CHAPTER ELEVEN

The Invisible Water Supply

It seems strange that Mother Nature, long before man appeared on earth, worked out a program which solved the problem that now seems so grievous. Man, "a newcomer in a world which is very old," to quote from the eminent Dr. Paul B. Sears, tragically dislocated and upset that program and showed that he did not understand a really simple process called the "hydrologic cycle." He chose to regard the operations of this cycle in a spirit of superstition. He talked about the "fury of the storm" or the "malignant floods" or the "wrath of the parching sun" as if the elements were gods or demons.

The hydrologic cycle simply is the process whereby the sun, sometimes aided by the wind, draws vapor out of the ocean; the wind carries the vapor inland; clouds form with partial condensation; they give up their moisture in the form of rain, snow, or hail with fuller condensation; the rain, snow, or hail strikes the ground;

water then either soaks into the soil or runs off (here occurs the crucial point of diversion which is the crux of this book). If it soaks into the ground, it nourishes vegetable life; it seeps into lower levels; it follows subterranean channels in porous material, finally to emerge in the form of springs; the clear water runs into streams; the streams flow into the ocean, and the cycle is complete and beneficial.

The natural operation is as given above. But surface runoff is largely abnormal. It culminates in fitful and rapid build-up of surface streams. Flow toward the sea is sometimes interrupted by misplaced and mischievous artificial barriers. With such artificially produced surface diversion there is a large amount of evaporation before the water has reached the sea.

When the water of a major level-land river is clear, it tells us that it has not received fine eroded material. If it is muddy, it warns us that it has received fine eroded material, temporarily suspended according to known geologic laws related to velocity.

It has been contended by some that even the primitive American streams were sometimes muddy. The Missouri River was called the "Big Muddy" even before the plow laid the soil open to wash. Analysis shows that this citation is irrelevant.

There are three probable causes of the phenomenon of turbidity in the case of the Missouri:

1. A state of inherent imbalance on semi-arid headwaters, analogous to that which prevailed in the Arizona-Nevada sector of the Colorado River in remote geologic ages. Heavy precipitation from the Rocky Mountains

flowed through an arid or near-arid zone which underwent a gradual uplift while the water wore a gash in the soil and erodible rock. The insufficiency of cloud-born and evenly distributed moisture in the Arizona-Nevada zone made it impossible for nature to produce the retarding agencies of vegetation and forest which otherwise would have produced balance and stabilization. This erosion was augmented by flash floods which occur even in the arid desert. A somewhat analogous situation was found even in the pre-plow era, on some of the high and sterile watersheds of the Missouri, for instance in the Bad Lands type of terrain, or some of the foothills of the Black Hills range. Geologic upheavals played a part in the defeat of the stabilization which nature ordains in the humid areas. So here we see a vestige of prevegetative conditions, with soil still more or less on the loose.

2. In the era before the plow there were enormous migrations of buffalo (and possibly other grazing animals), involving huge concentrations during drouth periods so that the naturally hardy prairie-grasses were over-grazed and exposed to the wash of rains.

The norm, however, is a situation in which nature heals soil-wounds with vegetation and forest in the regions of heavy to moderate rainfall and prevents a wholesale stripping of topsoil down to rock or tough, resistant shales and clays.

3. There were vast prairie fires started by lightning millions of years before man appeared on the scene. Such fires, after long drouths, bared the soil to erosion until nature could heal the wounds. A certain amount of sil-

tation was therefore possible even before the advent of the plow.

Going to the opposite extreme from the mile-deep Grand Canyon erosion phenomenon and its lesser prototypes, we find heavy jungles, even in areas where the annual rainfall averages up to 429 inches a year, as in the vicinity of Cherrapunji, India. The soil, necessary for continued growth, is not washed away. In fact it is built up by reason of the extremely heavy accretions of vegetable material, to which animal life makes some contribution. The land, in the natural operation of the hydrologic cycle, in its own locality, has its own automatic process of self-protection and self-perpetuation. Some of the heaviest Grand Canyon erosion takes place in an area that receives only about one one-hundredth of the Cherrapunji downpour. Behavior of these extremes throws a significant light on the whole problem.

In typical areas of the humid regions, according to soil conservationists, the land actually builds itself up at a rate estimated at one inch each 500 years. When you hear any one say, "there have always been floods and there has always been erosion," it is well to remember that they are necessarily speaking of exceptional cases and not the prevailing normal and orderly operation of nature's own land-use program. If that statement with intended implications were universally true it would obviously mean that the whole land surface would have been worn down to bedrock millions of years ago, whereas, on the contrary, it normally tends to build itself up. The automatic self-protection accomplished by nature under primitive conditions must therefore be

considered a self-evident proposition—with rare exceptions as noted. Again we must painfully admit that man is the chief agency for dislocating nature's magnificent process.

It is obvious that the orderly operation of the hydrologic cycle involves a tremendous, interlocking, interdependent mechanism, requiring the co-operation and collaboration of an infinite number of forces—delicate in detail but amazingly durable when balanced and united. That is the only complete and rational form of "hydrologic co-ordination," a term which has been lately prostituted by big-dam promoters.

An infinite array of case histories related to various types of unwise interference with the natural process could be compiled, such as the threat to the salmon-fishery industry created by the building of huge dams on the Columbia River—a threat which yet has not been fully resolved, even by the building of elaborate fish-ladders to maintain the avenues for the strange but vital upstream spawning instincts of salmon.

In June, 1953, the fish below the Pensacola dam on Grand River, Oklahoma, began to die in large numbers. At first no one could explain the phenomenon. Finally an authority on biology announced that the slaughter was caused by the fact that the power turbines at the big dam were taking a layer of water charged with carbon dioxide out of the lake and discharging this water into the river below the dam. The fish could not live in such water.

Nature, when not interfered with, guards against such eventualities. We never know when we are going to

run afoul of her inexorable laws if we tamper with the normal processes by interposing artificial processes or mechanisms. Those technicians who believe that all problems can be solved on the basis of one single and restricted branch of science cannot be expected to foresee any such complications.

In the book *The Web of Life,* by John H. Storer, the great truth is brought out that "man has only recently come to realize that all living things—bacteria, insects, grass, birds and mammals—fit into a pattern, that all are interrelated and that the whole depends for healthy existence on the presence of each of its parts. The study of these interrelationships—of how one living thing affects another—goes by the name of ecology."

It is disquieting to realize that the story of ecology, as related to the hydrologic cycle, is so new that we do not even have a name for what might be called "hydro-geo-biology," in the lack of a better term. We have hydrology, but its meaning is limited. We have hydrobiology, but it applies only to the life found in water. What we need is a comprehensive study of an applied science which shall describe all the orderly movement and functions of water.

The word "cycle" seems to have come by way of a double derivation. The Greek word for "wheel" is "kyklos." Other words, from other languages, are somewhat similar but they take a different shade of meaning, meaning "circle."

Taking the Greek concept, we might say that a wheel, in a great mechanism, should operate in an orderly

fashion, not too fast and not too slowly. The overall mechanism should not spin its wheels.

When a drive wheel strikes mud, it is likely to spin around. Mud, in one important sense, is an enemy of all life on earth. That is when it is in motion toward the sea, for instance in the form of turbid land-soup.

To preserve its integrity, the land cannot tolerate flowing mud, for that means erosion.

When there are sudden, torrential floods of muddy water, it is a warning sign that the hydrologic cycle mechanism is operating by jerks and sudden stops, particularly when the muddy water is allowed to flow in large volume into huge reservoirs. The mechanism is spinning its wheels.

Manifestly, the orderly, balanced function is achieved only when the natural process takes place—the absorption of the water into the soil, that it may fulfill its invaluable function of making food crops, forests, grass, and other forms of vegetation.

In one sense this is the most important thing that happens on earth, but mankind somehow has not made much of a practical, down-to-earth study of the whole continuing process.

It is important because, without it, we would have no economic structure. There would be no land life—nothing but a bleak desert like the landscape of the moon. The educators' failure to make this science an indispensable item in schools and colleges should be corrected.

The amount of water pulled out of the oceans by the

sun reaches into billions of tons a year. Nobody can ever tell just how much.

It is hard to measure the water from the time it falls from the clouds until it reaches the sea again. Some of it is lost by evaporation from the land, so the cycle is warped or shortened to that extent. Some of it is used for customary purposes, for instance irrigation, and soaks into the ground. It emerges in the form of a spring, or is pumped out, and may be used over again, to repeat the process. Much of it is "wasted," to borrow the language of one writer, because it goes into vegetation for which man has as yet discovered no use. Some of it becomes polluted and is thereby unusable. Some of it travels very slowly through the ground—as little as one-fifth of a mile a year in some cases.

"Trees give off quantities of water to the air . . . Someone has called trees 'the oceans of a continent,'" says A. C. Hottes in *The Book of Trees*. He adds that individual trees give off as much as a barrel of water by transpiration every twenty-four hours, saying, "Scientists tell us that trees give off more moisture than a body of water; furthermore trees give off more water than grass or fields of grain, because of their ability to tap the deeper and hidden sources of water, and their more abundant leafage." This is one reason why it is impossible to compile a statistical thesis as to the flow of water over and under the earth's surface, part liquid, part in visible vapor, part clouds, with shifting winds constantly at work to prevent measurement. If a given molecule of H_2O were to have its year's itinerary traced, it might be found to have traveled many thousands of miles, back

and forth in a zigzag pattern over the land, flowing in springs, being pumped upward through a tree-trunk, flying off into the air, falling as a snowflake in Canada, becoming a part of a boiling geyser, serving as bath-water or becoming an ingredient of a stew or helping to put out a fire, before ever getting back to the ocean. It is noteworthy that different authorities make different calculations. The estimates presented herewith are therefore to be considered elastic. They involve only the approximately measurable quantities. The rest must be imagined.

The continental United States receives an average of 30 inches of precipitation per year, ranging from almost nothing up to 80 inches. The midwestern and southwestern farm states receive from 20 to 60 inches (Louisiana not included). The west coast states get from 20 to 40 inches.

According to one calculation the total volume of water falling on the nation in an average year is 1,565 trillion gallons, if the 30-inch figure is applied to our 3,026,789 square miles. That counts up to 814,572 gallons per acre.

For all purposes *not including natural absorption by growing vegetation and trees,* the use is 200 billion gallons, of which about 30 billion gallons are taken from wells. So runs another estimate.

About 8 inches out of the 30 run off into the sea through streamlets and rivers, making roughly 25 percent of what is received from precipitation, according to a calculation made by *Life* magazine.

The humid areas are receiving an intermittent but

usually beneficent and adequate downpour, with a comfortable margin to spare. It makes crops grow and furnishes refreshment, nourishment, and economic benefits to the people.

There were no adequate rainfall records before 1870, and there have been imperfect data until recent years, yet it is certain, especially in view of the increasingly disastrous floods, that the surface runoff, now estimated at about one-fourth the total precipitation, is much greater than it was before the plow tore up the sod and exposed the soil to gullying and washing. At least it is probably greater in the channels in storm areas immediately after heavy downpours. Whether that proposition applies to the delivery of water at the ocean might be questioned, since the surface-running and surface-trapped water is subject to much evaporation, as noted elsewhere. Ground water is not subject to such evaporation, and it is conceivable that the total delivery of a theoretical river depending largely on springs would be greater than that of a surface-supplied river constantly exposed to wind and sun.

It would be hard to imagine a more futile or fruitless project than trying to evaluate "hydrologic co-ordination" on the basis of a few artificial reservoirs which, even if the grandiose $57,000,000,000 Pick-Sloan program were completed, could account for no more than one-thousandth of the enormous volume of water that moves fitfully over or under the face of the United States. Big-dam "hydrologic co-ordination" is an obvious fake.

The calculation would have to include such items as

25,000,000 gallons a day evaporation from 4,200 acres of the Oklahoma City reservoir supply on hot, windy days. It would have to include transpiration by countless billions of trees and shrubs and percolation through porous earth. It would have to include incalculable amounts of water that never reach the ocean as well as the volume that does finally reach the ocean. It would have to take account of the variable nature of evaporation through changes of atmospheric humidity, the variable effects of variable winds, etc.

Yet, in the winter of 1953-54, the Oklahoma Planning and Resources Board protested to President Eisenhower, Secretary Benson, and Secretary McKay that the Washita Valley Agricultural Flood Control Program was interfering with their studies of hydrologic co-ordination, so it should be kept under greater restraint! Bear in mind that the Washita Valley program, all the time, consisted of a strenuous effort to promote the very kind of hydrologic co-ordination that is found in nature in her own unbeatable hydrologic cycle.

This Planning and Resources Board, it should be explained, is extremely partial to the big-dam program.

One good way to prove the great increase of runoff due to plowing and gullying is to consider the 22-year records of the Red Plains SCS Demonstration Farm at Guthrie, Okla. These show by actual statistics based on runoff from various plots, that vegetation of various kinds reduces the runoff markedly, causing the water to take the slower, subway route to the sea. Open-tilled crops show a 22-year average of 10 to 11 percent runoff while sweet clover shows 3¼ percent and Ber-

muda grass only 1½ percent. Grass holds water about nine times as well as open tilled ground. Here we realize acutely how man has dislocated the natural operation of the hydrologic cycle. More of this later.

It is a matter of common knowledge that the water table has sunk to a serious if not dangerous degree in most parts of the United States.

There is a great ground-water deficit, based on the norm of 100 years ago. Industry requires increasingly large volumes of water, and ground water is preferable, according to the 1951 report of the National Council of Engineers. Some industries are withdrawing water which cannot possibly be replenished in this generation because, in some places, the rate of recharge from surface absorption into the known outcrop catchment areas is extremely low with the water moving only one-fifth of a mile a year.

The need of a continuing inventory thus is clear.

It is a trait of human nature to believe only what is seen.

The surface reservoir is instantly seen and understood. No imagination is required to form a concept that "here is water, for drinking, bathing, myriads of household uses, irrigation, manufacturing and whatnot."

Visualizing underground reservoirs and flowing water supplies is more difficult. Yet any citizen, concerned about water (and who isn't?) can learn significant facts about the unseen.

One of many ways of visualizing the enormous capac-

ity of the ground to absorb and contain water is to consider what the U. S. Department of Agriculture says on page 9 of *Agricultural Information Bulletin* No. 71:

"Good forest soils which take water quickly can hold 50% or more of their volume. This means that soil 8 feet deep may store about 4 feet of water."

Of course there are wide geological variations, including rock, hardpan, impermeable clay, etc., but the above formula indicates that large and important areas of our country furnish natural invisible storage capacity. Instead of 8 feet, take twice that depth, or 100 feet, or several hundred feet. There may be ten or fifty times 8 feet, with consequent storage potential that is almost beyond comprehension.

A hydraulic engineer told a recent meeting of the American Society of Civil Engineers that the Great Lakes form the greatest reservoir of sweet water in the United States, with a total capacity equal to two and one-half times the total annual rainfall of the nation. He went on to say, however, that the total ground water storage capacity of the United States is *eight times the average annual rainfall*. It is obvious that the ground storage capacity of the U. S. is many hundreds of times as large as all of the artificial reservoirs thus far built or likely to be built.

During the consideration of the Hope-Aiken Bill, to which reference has been made, a report was made by Rep. Hope which contains this significant passage:

"The soil is the most marvelous reservoir ever devised. The earth itself will hold more water than all the structures that man can ever build upon it."

Unfortunately the desire of many politicians to carry water on both shoulders led them to suck all the meaning out of this strong and courageous statement by saying that "of course big downstream structures would still be necessary." The latter statement could not possibly be true if the former is true, since the latter statement puts chief dependence upon man-made structures which the first statement so eloquently describes as being relatively incompetent.

An important part of the water supply of the Oklahoma City area, including the huge Tinker Field air base and factories, is a stratum called the Garber Sandstone, several hundred feet below the surface. This stratum furnishes an excellent quality of water. But wait! Because of that uncomfortable phenomenon known as the "sinking water table," the supply is steadily becoming more inaccessible. Remember here that we are discussing potential water storage capacity, not the actual supply.

Alarm over the diminishing supply in this instance is heightened by the fact that the flow through this sandstone layer is extremely slow—about 20 miles in 100 years. The supply will disappear if means are not taken to replenish the intake on an oblong area about 20 miles east of Oklahoma City, where there is outcrop of the Garber Sandstone. This supply must be recharged to an amount equal to withdrawal, or the water table will continue to sink. There is no mystery about this phenomenon. The catchment area is known. The rate of withdrawal is known. The water came from only one place—the clouds. In this particular case there are im-

permeable layers above the water-bearing sandstone at points of consumption, so the insoak and recharge are limited to the oblong tract just mentioned.

There is an infinite variety of catchment, recharge, infiltration and storage facilities in the ground. Sometimes geological faults play a part. In some cases water travels long distances underground before the vein is tapped.

At the state drouth conference, September 26, 1953, at Springfield, Mo., State Geologist Edward L. Clark said, in substance, that the water table—the top level of underground water supply—is constantly getting lower throughout the nation. The only way to bring it up again, he said, is to use surface treatment over the whole watershed to produce insoak of rain and snow water and start it seeping into the geologic layers that carry and store water.

In the same meeting L. W. Hornkohl, staff assistant to the State Forest Supervisor, made this remarkable statement: "We find that proper grazing management and protection from fire has a surprising effect on the absorptive power of forests. On a tract that had been thus protected for 15 years we found 2 inches absorption in one minute, whereas on tracts not thus protected, absorption required three or four hours."

Many authorities have painted a frightening picture of the sinking of the water table over the United States. There is only one adequate way of overcoming this calamity. That is by stopping water where it falls and producing the greatest possible insoak and recharge.

CHAPTER TWELVE

Insoak

For the earth which drinketh in the rain that cometh oft upon it, and bringeth forth herbs meet for them by whom it is dressed, receiveth blessing from God.—Hebrews, 6:7.

Insoak is the greatest all-around principle yet revealed in flood control practice.

Its importance in conservation has never been questioned, but it has taken accumulated object-lessons to demonstrate beyond a doubt that in the average-textured soil it rivals and often surpasses in flood control its companion device, the small detention dam.

This assertion does not in any way detract from the contention already made that the small detention dam is superior in flood control to the huge downstream dam in average respective locations. It is engineered to be superior.

Insoak is a necessary supplement to small dams. It bears the first brunt of the cloudburst, and when properly brought about, by use of plowpan-puncturing

legumes and grasses, chisel plows, terracing, regrassing, forestation, and other means, it has stopped rain where it falls—as much as 3.5 inches in 20 minutes. Even if it stopped only 3.5 inches in 20 hours it would still be superior to most of the big "flood control" dams, some of whose flood pools could accommodate no more than 1.3 inches of runoff on a complete watershed, as previously related.

Besides its power of taking up much of the water load, thus relieving or reinforcing the small detention dams of SCS, the insoak program acts as a guardian over those reservoirs by protecting them from siltation—the prime curse of big dams. Since it stops water where it falls, the water does not erode the land and wash silt down slope.

Jess Dewees has lived on his 320-acre farm northeast of Clinton, Okla., since he came as a small boy with his parents in a covered wagon before there were any roads—in 1894. He established the first full-scale conservation program in the western half of the state and, since 1942, he has been chairman of the big Upper Washita Soil Conservation District, which is more than 100 miles long.

"I'm stingy with water that falls on my place," says Jess. "I don't want any of it to get away from me, down slope. What's more, I'm stingy with Oklahoma water—don't want it to flow into Arkansas or Louisiana until we've had full use of it and it can run clear, mild, and steady. That means insoak. It means having full use of it on my own land, making crops or grass, then letting it seep down into the old spring-veins, to feed

creeks with clear water. That'll equalize it so it will finally get into the rivers and make them clear and steady too. In one way the job is to restore what I saw with my own eyes when I was a seven-year-old kid. I used to go swimming and fishing in Turtle Creek, a few miles west of here. It was deep and clear. Now it's dry sand-flats most of the time, but sometimes badly flooded with muddy water. No sense to that. We can bring back that clear, steady, deep stream."

The operations of Jess Dewees explain convincingly how floods are controlled on the individual farm by good land use. He has seven ponds. His cropland is all terraced. Wherever practicable he uses a grass program, contour furrowing and other approved practices. He even has a small wildlife refuge.

"On this 320-acre farm we've received 6 inches of rain in three hours without losing water," he says. "Everything being favorable, of course. In times of continued excessive rainfall I've seen some runoff from the lowest point of the farm—about three times in 15 years. However, one small detention reservoir of the SCS Washita Valley type would have easily taken care of that spillover, with room to spare. The reason my dams have been able to take care of runoff is that most of the water was soaked into the ground right where it fell."

His conservation district includes three subwatershed projects, one of them being the fabulous Upper Barnitz Creek job of 4,000 acres, which took care of a fantastic 13-inch cloudburst falling within 24 hours, May 16, 1951. The two detention reservoirs had no water going

over the spillways! Even the SCS engineers were flabbergasted. The drop inlets (automatic draw-down tubes) started patiently gurgling and glooping after the permanent pools (lower part) were filled, but kept the creek within banks even while neighboring creeks were roaring their devastation all over the landscape.

When you tramp over the Dewees farm, as the writer has done twice, you realize that if every farmer would duplicate Jess Dewees' job, there wouldn't be any floods except the 25-year species, and that when the SCS detention reservoirs are built, they take care of even such rare and excessive cloudbursts.

Dewees has used only the "ordinary" SCS methods—terracing, contour plowing, regrassing and use of farm ponds. If he had used deep chisel-plowing, special plowpan-penetrating legumes, and other refinements to be later described, the demonstration would have been even more startling.

Mr. and Mrs. Dewees own 71 head of registered Hereford cattle, have about 85 acres of plowland, and practice general farming. While young, they thought much of the strange rainfall pattern of that area. "It's either 'too much 'nuff or too much none,' my good old father used to say," Jess said on the hot, dry June day we toured his farm. "The weather goes from one extreme to another. That's why I say that if the SCS agricultural flood control program works here, it'll work anywhere. We certainly have the hardest possible tests of it. I'm completely sold on it. I don't care how many theoretical calculations the big-dammers produce, we've got the actual experience for proof."

In 1936 he started work on his "stingy" program, even before the Oklahoma SCS program got well under way. He did all the earth-moving himself. He had no tractor then, and used two fresnoes, powered by a four-mule team.

"All alone, I moved 100,000 cubic yards needed to build the seven dams," he said. "The CCC boys did the rip-rapping on the face of the dams. Then there are miles and miles of terraces, made with grader and plow.

"A neighbor stopped in at the house about that time. 'You're sure ruining that farm,' he said, kind of pityingly. I'd terraced everything, including a native buffalo-grass pasture, where I made small ridges." Here, Mrs. Dewees spoke up.

"One morning after it had rained all night, our farm looked almost like an ocean," she said. "We were certainly proud and happy. It was water, standing in those terraces and starting to soak in. From then on our crops got better and we didn't hand our floods over to the next neighbor down the slope."

"Yes," interposed Jess. "I'm sure I made more money with those flop-eared mules pulling a fresno and terracing plow than if I'd put the same extra work on the crops themselves. It wasn't long before all the neighbors admitted they were wrong, and they started the same program themselves."

He tells many significant stories about his adventure. Once an 8-inch rain fell, yet the two lower ponds of the seven-pond series still weren't full, because the crop ground, under conservation methods, had soaked in so much moisture. (This is one good place to refer back to

the testimony of Gen. Lewis A. Pick, who, as Chief of the Army Engineers, patronizingly admitted that farm soil, if parched and dry, might absorb as much as half or three-quarters of an inch, or a maximum of one inch, if the rain came gently.)

It took three years to finish the Dewees job—probably the equivalent of one solid year—since the work was necessarily interrupted by other farm work. Nowadays, the farmers with bulldozers and tractors get the work done in almost no time.

"I always like to work with dirt," says Jess. "And water. Dirt and water make a good combination."

How good a combination he produced by his insoak program was shown, as one of many instances, when he got 18 bushels of wheat per acre while his neighbors' average was 10. "And I got 50 percent more grass on the pasture-ridged land than I'd gotten before," he said. "I'm proud of my regrassing. I planted lovegrass, gramma, and native buffalo grass on old cropland. It makes beef and it stops the raindrops and starts them into the ground."

About the year 1947 the Washita Valley Agricultural Flood Control Program got well under way, with Jess as a prime leader. His big district contains three of the five subwatershed projects thus far completed—Upper Barnitz, Sandstone Creek, and Cloud Creek. Each one has a proud record in the job of chasing the raindrop up the creek and stopping water where it falls, so it will start its valuable task of feeding plant life while preventing floods.

From his farm we drove past Arapaho, county seat,

to the Upper Barnitz project, about 12 miles west of his farm. The detention reservoir was low—ready to take the next downpour. One of the most eloquent features of the landscape, about 300 yards up the slope, to one side, was a beautiful green field of maize, planted on the contour, with terraces. Yet there had been no rain except for tiny sprinkles for two hot months. That showed where a part of that 1951 water had gone—into the subsoil to make a crop instead of flowing down-creek and toting a lot of dirt with it.

"There's no doubt about it," says Jess—a bronzed, realistic, practical farmer. "The best way to stop floods is to stop every individual stream, holding both dirt and water. The smaller the trickle, the better. I aim to keep 'em right here." And he's doing it, on his own farm and, by his leadership, throughout the district. At the same time he is performing a great social service, doing his share to prevent floods from hitting the folks down on the main stem.

One of Dewees' close associates in the SCS crusade is Dick (R. C.) Longmire of Pauls Valley, president of the Washita Valley Council—an unofficial association of civic organizations, chambers of commerce and individuals that has energetically promoted the watershed program. Longmire also is a practical farmer and grain dealer, born and reared on the banks of the Washita.

"The more I see of this thing, the more I'm convinced that insoak is the next big thing in the whole conservation movement," he said to the writer. "I think it's the final big answer."

Almond D. Bull of SCS has been pioneering along the lines of insoak for several years, near Woodward, Okla. He has been inquisitively poking around in the soil with a machine he invented, called the infiltrometer. It measures the amount of water that sinks into any given soil profile.

Like Faulkner, Bromfield, Cocannouer and other students of this quirk of soil culture, he blames much of the farmer's grief on the tough plowpan (also called plowsole), and on the lack of organic content caused by soil-depleting crops. Breaking up the plowpan and using soil-building crops, he learns from his experimentation, have produced phenomenal—almost incredible—results.

First it is well to observe that the plowpan is not necessarily made by a plow, as many people have inferred. The moldboard plow has been blamed for producing a packed condition at the bottom of its soil-gouging operation. Mr. Bull finds that this is more or less of a coincidence. The fine clay particles in the upper layer of soil are brought down to a depth of four or five inches, and here they coagulate into a relatively impermeable layer. He says this coagulation can happen even in a fairly sandy-textured soil.

First take an extreme example in the transformation of soil. He tackled a field that had been cropped to milo maize and kafir for 35 years. The soil had lost 56 percent of its organic matter. Sheet and gully erosion was evident on the gently sloping fields. The soils were too sandy for terraces. The field recorded an insoak of only .2 inches per hour. At the end of a two-hour test the

water had penetrated only 5½ inches deep. But when the soil was removed to a depth of an inch below the plowpan, and thrown aside, the infiltrometer recorded the incredible rate of 9 inches of water absorbed per hour—45 times as fast—and it wet the soil to a depth of more than 40 inches in two hours.

By coincidence, equal penetration was recorded after a successful crop of sweet clover was grown and a two-phase operation tried. First the farmer used a chisel plow, 8 inches deep, and the insoak was increased from 275% to 400%. Then when he plowed under his lush crop of knee-high sweet clover, it absorbed water like nobody's business—10 to 16 times faster, wetting down the soil 40 inches.

Mr. Bull repeatedly produces insoak of 2 to 3 inches per hour by various types of treatment. By small-scale operations he has secured absorption of 9 inches per hour. He admits that this is under ideal conditions, but says that on a field-wide basis it is quite possible to secure 4.5 inches an hour by using proper methods.

At the Red Plains Demonstration Farm of SCS, near Guthrie, Oklahoma, Director Harley Daniel and his staff are working on what they expect to be a greatly expanded research program on insoak, hoping for a crumb of federal appropriations that might be left after the big-dammers have had their swag.

"We've already started operations on our Cherokee farm," says Daniel. "We're using chisel plows, going at least a foot deep. Also super moldboard plows going 18 inches deep or more. Then we are trying several combinations, including rotations of grass, sweet clo-

ver, wheat, vetch and other crops. We experiment with fertilizer to see the effect. Frequency of plowing is one factor to be watched."

The table below, compiled by Mr. Daniel and associates, shows highly important results, the most significant fact being that plowpan conditions are greatly intensified when land is cultivated, and that the soil above the plowpan constitutes a shell which promotes water runoff. The last figure of 6.6 inches insoak per hour for the soil below the plowpan shows that when that upper shell is penetrated, the rest of the insoak job is easy.

The rate of insoak on primeval buffalo grass sod, almost one inch per hour, is one more reminder that Mother Nature was doing a good job until the plow came.

Following is the table:

Land Conditions	*Rate of Infiltration in inches per hour*
Continuous Wheat	.168
Formerly Buffalo Grass Sod*	.920
Continuous Wheat on Friable Sandy Clay Land	
Undisturbed Surface Soil	.102
Soil Below Plowpan	1.330
Continuous Wheat on Friable Silt Loam	
Undisturbed Surface Soil	.040
Soil Below Plowpan	6.600

These tests indicate that the entrance of water into the soil was limited by the *surface soil and plowpan*

* This plot had been in buffalo grass for 5 years. The sod was destroyed by plowing in July before these tests were made in September.

conditions. They also emphasize the value of *grass* for permeating the soil. After a plot had been in buffalo grass for five years, the sod destroyed and the seedbed prepared for wheat, the rate of infiltration of water into the soil was five times as fast as that on an adjacent plot of continuous wheat.

Using both literal and figurative language it can be said that only the surface has been scratched with regard to the insoak factor. Hampered by insufficient funds, SCS is so overwhelmed with demands for research and technical guidance in the other and simpler forms of practice that it has barely made a start in the insoak adventure.

A concrete instance of insoak was seen in the SCS-treated portion of West Owl Creek, tributary of the Washita River, Oklahoma, May 9-10, 1950.

The standard engineering calculation was that standard surface treatment, for example terracing, regrassing, contour furrowing, etc., would absorb 3.5 inches falling in great intensity. Then the detention reservoirs would impound up to 4 to 5 inches, making a total of 7.5 to 8.5 inches dumped on the land as fast as the clouds could empty themselves.

The record, however, was that the project actually absorbed 12 inches of extremely intense rainfall in five hours, and a total of 13.5 inches in 48 hours. These are the most conservative figures available. The creek below the last structure did not overflow its banks until it had traveled a mile farther, by that time receiving runoff from untreated terrain. This means that the actual insoak of treated fields was 7 to 8 inches in five

hours and considerably more in 48 hours, as indicated. Jess Dewees had a finger in this pie, too.

To use the SCS idiom, the project was expected to control a 25-year flood and it actually took care of a 100-year flood. Yet it employed only the standard SCS surface treatment, not the intensive techniques with which Mr. Bull pioneered and blazed the way for great things.

The first of the Washita Valley subwatershed projects to receive a severe test was that of Cloud Creek, in 1948, when a rain of 4.6 inches fell within four hours. The insoak was so good that the surface treatment took care of most of the deluge, and the detention dams did not even fill up to the drop inlets (drawdown tubes for excess water above the permanent pool). So not a bucket of water came out of that project into the Washita River, though other creeks in that area were on the rampage, producing a bad flood at Anadarko.

Since agronomy is an integral part of land use study, it is interesting to note that Mr. Bull's research strongly indicates that oxygenation and generation of amino acids are promoted by breaking the plowpan. Deficiencies in this respect cause wheat to be more susceptible to green bugs than when the roots freely penetrate the ground to normal depths. Light is thrown upon this study by the fact that he found three tons of wheat roots below the plowpan in one acre not properly treated, compared with six tons above the plowpan.

The item of allegedly excessive soil saturation in a prolonged storm period is stressed by big-dam engineers

who ridicule the idea that insoak can have a powerful effect in flood prevention. Mr. Bull, however, finds that the rate of infiltration in ideally treated soil continues indefinitely. A chart of insoak showed that for six hours there was a straight line—no curve such as would occur if there were super-saturation. Obviously this straight-line chart points to steady and indefinitely prolonged seepage to lower levels, in the average soil type, with consequent ground storage. This, of course, would vary with geological factors, but the fact that an ideal insoak can continue is of prime significance. Consumption and optimum utilization of water by growing crops, while the water is on its orderly downward course, will constitute another subject for research. The foregoing items were comparatively fresh from the research station as this chapter was written. As said before, the science of insoak is still in its infancy.

The efficacy of forest land in producing insoak has been mentioned. Johns Hopkins University, at Seabrook Farms, New Jersey, tackled a project in which disposal of surplus water was a special local problem. Various types of land treatment were tried and finally a forest cover was tried out. Water was sprayed on the woods, and absorption up to 50 inches in ten hours was reported, with a total of 100 feet in a year in spots, according to a news release of the *National Geographic Magazine* late in 1952.

In the overall picture of the prairie area the most important of all flood prevention agencies is grass.

Two soil conservation experts of the Washita Valley

—Sellers G. Archer and Clarence L. Bunch—have recently written a volume called *The American Grass Book,* which is an important work of its kind. Here are significant excerpts:

"In measured tests at the Soil Conservation experiment station at Urbana, Illinois, the percolation of water into grassland was twenty-two times as fast as movement into intensively cultivated soil . . . The first tenet of flood control is adequate treatment and protection of the entire watershed. Any flood-control program that omits this important factor is doomed to ultimate failure and will leave costly and glaring monuments to the short-sightedness of its planners . . . One thousand acres of good grassland will provide a reservoir for water in the soil equal to a 1,000-acre detention reservoir or lake."

The book *Grasses and Grassland Farming,* by Prof. Hi Staten of Oklahoma A. & M. College, likewise demonstrates the inestimable value of grass as cover and erosion control. The literature on this point is voluminous and convincing.

The decrease in grass acreage is reflected in a corresponding increase in the destructiveness of floods.

Even without thinking of flood prevention as a direct objective, enlightened farm leaders everywhere have emphasized the importance of a grass economy.

Some years ago the writer attended one of the numerous soil conservation conferences in Oklahoma and was struck by the statement of the county agent of Dewey County. He spoke with great pride of the farm acreage that had been put back into grass—the primi-

tive cover of the plains—in the previous year. Time was when agricultural progress was measured by the destruction of grass. Now the exact opposite is true. The regrassing movement is one of the most hopeful elements of sound water control policy.

The overall picture, involving the use of grass, forest cover, legumes and even weeds in some cases, is that of reconstructing the vast absorbent sponge that once covered America. It should be said in this connection that the texture of the soil itself is an important factor.

According to Dean Louis Hawkins of Oklahoma A. & M. College, soil that is well charged with organic matter will absorb far more water than soil deprived of such matter, which runs together in a paste and promotes fast runoff.

And, according to Joseph Cocannouer, author of *Weeds, Guardians of the Soil,* many weeds act to enhance the sponge action, by fiberizing the soil, adding to organic content and withstanding erosion.

J. N. Darling, famous cartoonist, known also as one of the foremost conservationists of the nation, served as Chief of the U. S. Biological Survey during the fore part of the Roosevelt administration, and he calls attention to the "miracle of restoration accomplished in what is generally known as the Sheldon Antelope Range in northwestern Nevada." He says:

"It is a perfect demonstration of what ground storage of precipitation moisture can do in a semi-arid piece of land of over a million acres, which 25 years ago had been so mistreated that even a grasshopper would starve to death. Cattle ranchers and sheep herders had finally

withdrawn their herds for lack of sustenance. There weren't enough sage-hens to tempt a hungry coyote and the few hardy prong-horned antelope who remained in that area were approaching extinction and none of their progeny lived over the next winter after they were born.

"This area came under my administration in 1934. The Refuge was originally purchased by the Boone and Crockett Club of New York City, of which Theodore Roosevelt was the leader and inspiration. They bought the land and gave it to the government in the hope of saving the antelope. It had never been even fenced, and cattle and sheep roamed over its surface until there was no food left. My first visit to it revealed seven water-holes where, in times gone by, sheep and cattle and wildlife had found sustenance when all other resources failed. When I first saw it those seven water-holes were dry as a baked 'dobe brick, the land as barren as the middle of the paved thoroughfare of Broadway. When I first saw it, it was the most desolate piece of the American continent I had ever visited, but it was a Refuge and I was supposed to make it perform as one.

"The only thing I could think of at the moment was to put a fence around it and keep the cattle and sheep from such heavy competition, with the few sprigs of ryegrass on which the antelope were supposed to sustain themselves. The fence kept the cattle and sheep out, and by fall of that year there was so much ryegrass and bunch grass showing on the former barren surface that it held the snows of that winter in one great white sheet of landscape. Outside the fence, where the grass

had been gnawed down to the roots by the last of the sheep herds, the snow had all blown off into the dry gullies and left the surface of the fields a dry dusty waste.

"The next spring the snow in the gullies melted and ran off through the ditches but on the Refuge inside the fence, snow, which accumulated in the grasses and was held there against the heavy winds which swept that area, lingered on after the gullies were dry. The snows on that Refuge area melted and went into the ground. There was no runoff.

"That summer there was water in those seven old water-holes until the middle of July, and that was the first time it had happened in many years.

"The second year the water-holes were full at the end of August, and now there is a continual supply of water in all those seven water-holes, vegetation covers the entire Refuge, and an old well on the Refuge headquarters again has water, maintained from the ground storage of winter precipitation alone. That is what a sparse crop of ryegrass and bunch grass will do for the ground storage of water. Cattle and sheep men look through our fence at that great green pasture with amazement, but the administrators of the Taylor Grazing Act, though conscious of that conspicuous miracle, refuse to administer the public lands according to the lesson demonstrated in that one simple experiment."

About 75 years before this book was written, John J. Ingalls, the senator and brilliant orator and essayist, living in what he called "the grassy quadrangle called

Kansas," paid tribute to grass in a powerful essay, including this passage:

"Its tenacious fibers hold the earth in place. It invades the solitude of deserts, climbs the inaccessible slopes and forbidding pinnacles of mountains, modifies climates, and determines the history, character and destiny of nations."

Modern research has immeasurably strengthened his intuitive intelligence. Now it is possible, by strip-cropping, the use of terracing, chisel plows, plowpan-penetrating legumes and other means, to maintain enormous insoak even when open-tilled crops like corn, maize, soybeans, and cotton are involved, especially when rotation programs are followed and the land is kept supplied with organic matter and fertilizing agents.

The double peril of floods and the dropping water table make it imperative that land-grant colleges, the SCS and other agencies and institutions intensify special research on insoak.

The upper Washita basin program comprises the most difficult tests in the efficacy of watershed absorption as contrasted with big reservoirs. Much of the land is tough and produces rapid runoff, and it is visited by extremes of wet and dry, in which the dry periods inhibit the growth of vegetable cover that otherwise would appear. The successful operation of watershed control here plainly indicates that even greater success will be found in the areas of more and better-distributed humidity.

The big-dam and levee system, with irrigation canals, is a 6,000-year-old concept. It was tried in Babylonia,

and on the Hoang-Ho in China at least 60 centuries ago. Babylonia was founded on irrigation and it died of siltation, as told by the impartial *Encyclopedia Britannica.*

It is crowning irony that even now, as this book is written, this ancient pattern is being suggested as a "Jordanian TVA" not far from the Babylonian fiasco, suggesting that many hydraulic engineers have learned nothing in 6,000 years. Their system has been a ghastly flop.

The obvious cure for the agricultural poverty of the Holy Land is to stop water where it falls. That is the modern, scientific way.

The simple and proved fact is that in the average prairie plowland, no big-dam program, pro rata, can approach the water-impoundment capabilities of the watershed practices.

CHAPTER THIRTEEN

The Washita Program: Agricultural Flood Control in Action

In previous chapters several references have been made to the Washita Valley Agricultural Flood Control Program, without delineating its inception, its specific nature and overall function. It is now appropriate to explain such particulars.

This is not the only project of the kind, since, at this writing, there are ten others in the nation, but this one is regarded as more or less of a "pilot" project—at any rate it has received more national publicity than any other. Since the writer lives within an hour's easy drive of the watershed, he has become especially familiar with it.

The project is under the direction of the U. S. Soil Conservation Service, a division of the U. S. Department of Agriculture.

As this chapter is written, in 1953, five subwatersheds—creek-valley subdivisions of the valley—have been given a prescribed course of treatment, which is that of preventing floods, not by big dams but by small detention reservoirs and surface treatment including terracing, contour furrowing, revegetation, reforestation, strip cropping on the contour, and related practices.

The total area of the Washita Valley, extending a short distance into west Texas, is a little more than five million acres. The five subwatersheds—Cloud Creek, Upper West Owl Creek, Mill Creek, Sandstone Creek, and Upper Barnitz Creek—contain a total acreage of less than 100,000 acres, so (as of 1953) less than one-fiftieth of the total area has received the treatment which began to be applied during 1947.

Under the Flood Control Act of 1936, a new policy of flood control was launched, namely the stopping of runoff where the rain falls, or as near there as possible.

Eleven projects were authorized, with approval of federal funds, as indicated:

Los Angeles River, California, $8,380,000.
Santa Ynez River, California, $434,000.
Trinity River, Texas, $32,000,000.
Little Tallahatchie River, Mississippi, $4,227,000.
Yazoo River, Mississippi, $21,700,000.
Goose River, Georgia, $1,233,000.
Little Sioux River, Iowa, $4,280,000.
Potomac River, Virginia, $859,000.
Buffalo Creek, New York, $739,000.

Middle Colorado, Texas, $2,693,000.

Washita, Oklahoma-Texas, $11,243,000.

Authorization for the beginning of work on these projects was made by Congress in 1944.

Louis P. Merrill, when regional director of SCS at Fort Worth, Texas, made the following statements in regard to the Washita program:

"Never before has such an attempt been made on so large a scale to reduce the frequency and severity of floods by holding more rain water on the uplands, where it falls, and by retarding runoff of the remainder . . .

"The Department of Agriculture's watershed flood control program is based upon a detailed survey of the Washita River watershed. Three agencies of the Department of Agriculture—the Soil Conservation Service, the Forest Service, and the Bureau of Agricultural Economics—co-operated in making the detailed survey of the 5,189,000 acres comprising the watershed. As a result of the survey, the department in 1942 prepared a comprehensive soil conservation program which Congress authorized in the 1944 act for post-war operations, the work to be completed in 15 years . . .

"The flood control program will be carried out through the soil conservation districts which now cover 96% of the Washita watershed. Through its technicians the Soil Conservation Service will assist the districts upon request just as is done now in the regular conservation work. Farmer cooperation with the soil conservation districts will continue to be voluntary as at present. . . . The share of the farmers and ranchers

in the work is valued at $3,169,000, practically all of it representing labor, equipment, and materials available on the farm."

Mr. Merrill then observes that the upstream flood control program on the watersheds "will supplement and complement the down-stream program carried by the Corps of Engineers of the War Department."

There are various ways of interpreting this specification, but it has to be borne in mind always that the Soil Conservation Service, so far as the mechanics of bureau operations are concerned, has no choice but to accept what is ordained by higher powers, whether by "Inter-Agency" agreement or executive order or acts of Congress, or what-not. Apparently the high officials of SCS are recognizing an uncomfortable bureaucratic necessity. Certainly there are good reasons for SCS officials opposing the large downstream dams, which subtract vast areas from the richest farm lands and thus function directly contrary to any rational conservation program, but the reader of this book is entitled to make up his own estimate, based on the evidence.

The writer has had abundant opportunity to watch the SCS technicians in action and to listen to their observations, accompanying them on field trips, being permitted to examine a vast quantity of their data, etc. Assuming the right to draw a few conclusions from long and sometimes intimate contact, it is the writer's firm conviction that the technicians were unprepared for the results of their own operations, and were often flabbergasted to find that the SCS program actually exercised a much higher degree of flood control than they had

calculated—or that any of the huge dams could perform. It is therefore difficult to understand any statement that the big-dam system should be used to "supplement" the small-dam and conservation system. The small reservoirs duplicate and far excel the big reservoirs in impounding watershed runoff. There can be no dividing line between the tributary watershed and the source of downstream flood water. They are clearly identical.

The foregoing statement, again, applies chiefly to the prairie plowlands. Possibly there are unusual conditions in certain mountainous areas which would call for a different conclusion.

During the long and increasingly complicated controversy going on in Kansas and other parts of the prairie region, some of the top echelon SCS officials occasionally have produced theoretical statistical evidence which seemed to discount the flood prevention functions of the Washita program. Bearing in mind that the Inter-Agency agreement forces upon them a mixed and somewhat nondescript policy of "getting along with the Army Engineers somehow," it is important to know how and why they arrived at their theoretical evidence.

It was done by taking small trial plots and getting an engineering figure as to rate of absorption, slope, soil texture and other factors, then expanding those figures theoretically in what are called "work plans" to cover the whole valley. In the absence of actual floods the "design" (theoretical) deluge was used.

The all-important thing to remember is that whenever a subwatershed was treated with the SCS program, the

actual results far exceeded the theory-based "work plans." These technicians always take the most conservative figures and go on from there. This explains the discrepancy between theory and actual results.

A concrete and dramatic instance of this discrepancy is seen in the brochure *Upstream Flood Prevention in the Western Gulf Region.*

On page 18 is found a complete and convincing proof that the Upper West Owl Creek program actually stopped a cloudburst of 13.5 inches "from a two-day storm," which is a feat beyond the wildest dreams or claims of the Army Engineers on proportionate watersheds, in their own "flood control" projects. Yet, from the remainder of the brochure, the reader gets a confusing theoretical picture in which flood control capability estimates range from 25% to 98%. The low estimates, for which no concrete evidence is produced in the brochure, are avidly seized by the big-dam propagandists and used in their remarkably successful efforts to defeat most of the agricultural flood control programs and appropriations. How the writers of such a brochure expect to advance upstream flood prevention by such self-belittling means is hard to understand. They can't get appropriations if their statements are quoted in a way to discount the value of their own cause. Of course the big-dammers don't use the 13.5-inch illustration, which tells the *real* story. They use only the most belittling theoretical figures they can select from a mixed and confused story.

The remarkable actual performances of Upper West

Owl Creek, Upper Barnitz Creek, and Cloud Creek subwatershed projects demonstrate the effectiveness of the Washita program. Upper West Owl took care of a 13.5-inch cloudburst; Upper Barnitz took care of a 13-inch cloudburst; Cloud Creek took care of a 4.6-inch cloudburst falling in four hours.

The big Sandstone Creek project of 65,000 acres, up to the time this book was written, had not received such a drastic test, but on May 16, 1951—the same day of the Barnitz performance—a 4.57-inch rain fell within 24 hours, according to the nearest weather observation station, and the detention dams had not begun to extend themselves, and no flood entered the main stem. According to L. L. Males, a Cheyenne banker, who is one of the main supporters of the project, such a downpour created serious flood conditions at the mouth of Sandstone in previous years.

No official rainfall measurements were available on the Mill Creek project in May, 1950, when a heavy storm occurred, but the writer talked with the occupants of one of the largest ranches there and the report was of a 6-inch downpour, with complete control.

There is, therefore, an unbroken record of perfect performance, with every promise of a continuation for the future, probably even with a "100-year" flood. After all, it is performance that counts.

In connection with the Upper Barnitz Creek performance, it is interesting to draw a comparison involving the Kansas flood of two months later.

The rainfall in that record-breaking 1951 Kansas

flood reached a total of 18 inches in one small spot, with concentric zones shading down to 16-inch, 14-inch and 12-inch deluges.

A comprehensive record, with map, was published in the *Topeka Capital* soon afterward. Official weather reports were used. This showed that in the main period of the storm there were two peaks, one near the beginning and the other near the end of a five-day period. Time is of the essence in any flood period. Having a deluge spread over five days is quite different from having it all come within one day, as in the case of Upper Barnitz.

All things considered, it seems that the Barnitz rainfall was more severe in its area than was the Kansas rainfall in its area.

As usual, the big-dammers argued that prolonged soil saturation in Kansas was the "straw that broke the camel's back." That could have been true in regions where there was no appreciable practice of soil conservation methods. It happened in fact that a portion of the deluged Kansas area had been given the approved SCS treatment when the great flood came.

The Schippel neighborhood, east of Salina, involved 2,500 acres of rolling upland sandy soil, with about 40% of the upland acreage under plow. Flash floods from this upland had rushed down, in previous years, to flood 1,200 acres of rich bottoms. Much sand was carried down and deposited over the rich soil. A big drainage ditch filled with sand, and everything was a mess.

Jay Payne, District Conservationist for the SCS, was

called upon for help. The county extension service, the state PMA and local machinery dealers helped. Fifteen bottomland farmers chipped in $2 an acre to remedy the financial deficiency. Half a dozen detention dams with drawdown outlets were built. A big job of terracing was completed, along with other approved practices.

Came the 100-year flood of July, 1951. This area was near the point of heaviest precipitation. Let Jay Payne tell what happened:

"The Schippel watershed . . . received two five-inch rains on successive nights—10 inches in 24 hours. It came through with flying colors and the runoff water stayed in the ditch below, as it was designed. The water did not flood the bottomland as it did before the conservation measures were applied by the upland farms. About 36 hours were required to drain the water from some of the detention dams."

So we see from internal evidence in the Kansas situation—even though the acreage was not large enough to bring appreciable effect on the total picture—that the SCS system does the job. The terrific water-bombardment that had hit Oklahoma's Barnitz Creek two months before provided a good lesson, obviously applicable in Kansas.

The three principal elements of flood prevention in the SCS program are:

1. The surface treatment, including terracing, contour furrowing, revegetation, with consequent insoak.
2. The impoundment of runoff in the flood pool of the detention reservoir.

3. The automatic regulation of released water which may accumulate above the drop inlet in the flood pool. By using an outlet tube of given calculated size, this released water will not overflow the banks of the creek below the dam.

The overall calculation is that if all the tributary creeks are kept within banks, the main stem will not overflow.

Conceivably this would be theoretically true even if the entire 5,000,000-acre watershed were to receive a 25-year deluge, but that never happens, since, in the Mississippi Valley, the most intense rainfall is confined to spots of not more than 50 to 100 miles in diameter.

Reclamation of gullies is suggested through the method of changing the sides of the gullies into gentle slopes, then sodding them or seeding grasses or planting shrubs and vines, according to the nature of soil and topography. Interception or diversion terraces are also used to protect valuable land below slopes or to check erosion. Weeds and brush, which sometimes threaten grass cover, can be controlled by mowing or clearing, the latter including the use of chemicals.

Pasture management with rotation of different types of grass, so that cattle may be kept busy during the entire growing season, is a prime factor in this program, since over-grazing is one of the most prolific causes of erosion and runoff.

In the Washita Valley area more than 300,000 acres have become virtually useless for cultivation or pasture, and under this project it is expected that the federal government will purchase such abandoned land, and

proceed to apply intensive soil rehabilitation, with no crops or grass taken off, so that it may eventually be restored and perhaps gradually put back into production.

The economic phase of the Washita project indicates that benefits of almost five million dollars a year may be realized by farmers and ranchers from installation of the land treatment program, to say nothing of the flood control benefit which accrues to a more general public. "It is figured that of the total cost, every dollar will bring a net return of $3.85 in benefits," says Mr. Merrill, speaking of the direct returns to land users.

Considerable research has been done in ascertaining the cash value of the conservation program. A four-state survey shows that the average immediate increase in crops after such treatment amounts to 32 percent.

Smaller example areas in the Washita Valley provide the following indications, according to Merrill:

"Recently 275 farmers operating 75,000 acres in the Rolling Red Plains, through which the upper Washita flows, reported the results of their conservation farming. Their co-ordinated conservation programs had been applied 70 to 100 percent for at least two years. They had reduced their cultivated land an average of 5 percent and increased grazing land 6 percent. They reported that their conservation farming produced an average of 34 percent more grain sorghum, 29 percent more corn, and 21 percent more cotton per acre. In the Oklahoma Cross Timbers 191 farmers operating 38,827 acres reduced cropland by 14 percent and increased grazing land by 30 percent. They put some 1,400 acres of idle land back to work. Their report showed they

were producing 24 percent more cotton, 22 percent more grain sorghum, and 40 percent more corn per acre. Forage production in their pastures was 39 percent higher."

In the *Journal of Soil and Water Conservation* for May, 1953, two technical experts, after making an exhaustive survey of 48 Illinois farms, found that each dollar invested in conservation practices brought a return large enough to pay for the improvement, plus $1.18. The "high" farmers registered crop increases averaging 72 percent.

As you approach the mouth of the Washita River, where it flows into the artificial Lake Texoma, you plainly see the ravages of bottomland flooding, which will continue to grow worse unless the valley program is rapidly completed. The farther down you go, the greater the flood problem becomes, but every seeing eye perceives where the problem originated and where it must be cured—on the upland. Erosion, siltation and flooding are inextricably wrapped up in one repulsive and constantly worsening package, so you are increasingly reminded that any arbitrary separation of the "main stem" problem from the watershed problem can only lead to unscientific bungling and failure to see the pattern whole. Flood waters come from little waters. The silt you see in the river channel, on the overbank of the entire flood plain and in the mounting delta at the river-mouth, is silt from little gullies scores of miles up the valley, and from sheet erosion on the uplands, and that silt constantly increases the flood menace. Since less than one-fiftieth of the total valley areas has been

given the proper SCS treatment, there still is a long way to go, but it is clear that the downstream happenings will depend vitally upon what happens on the tributary watershed. The whole river system is solidly integrated.

Before the artificial lake was built, much of the silt went down into the Red River and eventually into the Gulf of Mexico. Now all of it is stopped cold as soon as the moving water hits the still water of the reservoir, so the water near the dam is telltale clear, and shines blue in the bright sun.

In the meantime the cities and towns in the flood plain are menaced more and more every year. Pauls Valley now expects the river to be flooded on the average about one year in three, according to performance since the big reservoir was built. In 1950, the writer was on the ground immediately after a $5,000,000 flood, and saw where the Washita River had actually cut back of the city, on its west side, and had flowed into its own tributary, Rush Creek, showing how crazy the meandering had become, due to the pile-up of silt.

The Washita Valley situation is mixed, involving both bright and dark sides. The bright side is the gradual but too slow adoption of watershed flood prevention. The dark side is the continued destruction by erosion and flood, plus the sabotaging tactics of the enemies or inadequate friends of watershed flood control, who divert all available federal funds to their own projects. The politicians still love pork.

The big-dam lobby registered considerable strength in the report of the subcommittee on Public Works, December 5, 1952, which devoted all its hostile attention to

agricultural flood control and openly urged that it be completely abolished and that the USDA be prevented from even making surveys for such a purpose "or for erosion control."

The adoption of the agricultural flood control plan in the eleven river basins previously mentioned is too slow, making it look as though the big-dammers are trying to wear out the patience of the watersheds advocates and cause them to abandon the projects as hopeless.

There seems to be only one force that can circumvent the organized big-dam lobbies. That is the power of public opinion.

The writer is convinced that public opinion, where there has been fairly adequate information, is overwhelmingly on the side of the watershed school of thought.

"Where you can get 2,000 farmers together—if you could take a vote—you wouldn't find a single vote against watershed flood control." So says Harry James, county farm agent of Oklahoma County.

The Washita Valley Council, a group of individuals and of accredited representatives of chambers of commerce, farm groups, civic clubs and the like, made a hard fight, in 1952, for increased appropriations, to speed up the work. Without difficulty the officials secured 50,000 signers to a petition to this effect. There was no opposition. Straw votes showed an overwhelming support, not only in the Washita Valley itself, but everywhere in the state.

The response of Congress was niggardly, though the

politicians secured appropriations totaling about $200,-000,000 for the PMA "conservation payments," which are a phase of that same "gentle rain of checks" instituted by Henry A. Wallace under the old AAA label when he was Secretary of Agriculture. This preservation of high "gimme" appropriations occurred despite the opposition of the Grange and the American Farm Bureau Federation, which demanded substantial decreases in such payments. These "gimmes" are often flagrantly unnecessary and uncalled for, as, for instance, in the building of large fish ponds for wealthy land-owners who could just as well pay for such improvements themselves. The conservation treatment of the watershed program is badly needed as a defense against erosion and flood. So this $200,000,000 appropriation meant "millions for tribute and not one cent for defense," reversing the familiar patriotic slogan of the past.

There are many fascinating aspects to this "fight for the valley."

The Washita basin includes scores of thousands of acres of fine alfalfa lands, producing as many as five crops a year. There are other large acreages of corn, cotton and wheat, and still larger tracts devoted to grazing.

The bottomlands are threatened with the choking of channel due to backwater sedimentation. The blight is already plainly visible. The river is beginning to meander crazily from side to side, as water always does when it flows over a flat, sandy surface. The former stabilized channel, once bordered by stately trees and green banks,

is demoralized, in long stretches, giving way to wide sand flats. This means the destruction of large acreages of fertile bottomlands.

Rep. Howard S. Miller of Kansas (in the famous Blue Valley district) urged the appropriation of $5,000,000 for watershed treatment in his own state. It was defeated, and Miller bitterly called attention to the fact that this item was one fifteen-thousandth of the national budget.

Here in the Washita Valley is an experimental laboratory which, in certain vital respects, constitutes the biggest news story of this era. In reality it is no longer an experiment, but a well-proved demonstration. Yet it encounters the baffling inertia of bureaucracy and the underground intrigues of selfish lobbyists who prefer the pork-barrel system to the system of common sense and modern science.

The laboratory is a well-balanced, well-supervised food machine which brings much more than 100 percent interest on the money invested in it. This money goes immediately into the national economy and it preserves for future generations the food-productive mechanism that is absolutely necessary. But the big-dammers fight it desperately.

A few earnest students have asked the question: "If the five subwatersheds in the Washita Valley of Oklahoma provide a successful demonstration of the principle of agricultural flood control, is that any guarantee that the system will work everywhere in the prairie plowlands?"

It is a fair question, and of course the final answer

will not be available until and unless the system is tried on all types of terrain. However, all the combined evidence suggests an emphatic affirmative answer.

The terrain in the five widely scattered subwatersheds ranges from hilly to almost level land of gently rolling nature, from hard clay to mellow sandy loam, with various intermediate soil types. The annual rainfall varies from 20 to 32 inches. The whole area is subject to rather drastic extremes of drouth and wet, and that fact provides the most exacting of all tests, since, under the ordinary non-conservation type of farming, with considerable open tilling and susceptibility to gullying, the long dry spell thins the cover vegetation and the extreme runoff causes destructive flash floods of high intensity. Conversely, the areas of long, drizzly rains elsewhere in the Mississippi basin provide conditions most conducive to sponge action.

Others have said: "In the northern states sometimes there is a sudden thaw of heavy snow in the spring before the ground can thaw out, so the runoff is very fast. How will the SCS system work under such conditions?"

The writer was born and grew to manhood on a farm in that region and knows the situation well. The answer is that the small detention dams are engineered to impound up to 4 or 5 inches of rainfall, the equivalent being 4 or 5 feet of snow. Added to such impoundment is the retention of large quantities in terraces, with exposed contour furrows furnishing still more catchment. Grass and other cover crops also exercise a valuable degree of retardation.

After all, soil and water behave the same everywhere,

assuming analogous geological formations. The writer has lived long periods in Iowa, Kansas, and Oklahoma and has found no material difference in basic problems.

The Washita program of agricultural flood control has proved its effectiveness. Although the Army Engineers deride it, it has been endorsed by many outstanding civilian engineers. Often, however, they were reluctant to be quoted because most professional men regard unusual data as being "sensational," even if true. It was with a great deal of satisfaction, therefore, that the writer received the following letter from Courtlandt Eaton of Colorado.

Before quoting the letter, a little background is desirable.

Courtlandt Eaton belongs to the American Society of Civil Engineers and is the author of authoritative articles in his field, which is that of flood control, the building of large dams, and hydraulic engineering in general. His biographical sketch in *"Who's Who in Engineering* is significant. He was Irrigation Commissioner of California, Chief Engineer of the Los Angeles Flood Control District, Construction Superintendent of the Water Supply of the San Francisco Pan-Pacific International Exposition, Engineer with the Consulting Division of Chief Engineers' Office, U. S. Bureau of Reclamation, and engineer for many large dams, up and down the Pacific coastal area, where hydraulic engineering has had its greatest play.

His letter to the writer was prompted by his reading of the article entitled "Big Dam Foolishness," in the

Country Gentleman of May, 1952, condensed by *Reader's Digest* of July, 1952.

It is dated June 25, 1952, and reads as follows:

> The principles you express ("Big Dam Foolishness" *Reader's Digest,* July 1952) are sound from an engineering, economic and common sense standpoint. As a flood control and conservation engineer I have battled for multiple structures [not to be confused with multiple-*purpose* reservoirs. —E. T. P.] with some measure of success but not as much as I desire.
>
> It is simple common sense to control any disastrous threats at their sources. Adequate flood and erosion control calls for multiple regulating storages on the tributaries. Among the advantages are:
>
> (1) Speed of construction. Obviously a number of small structures can be built concurrently in a fraction of the time needed for a single major structure.
>
> (2) Safety to lives and property. Failure of a small structure in the upper reaches of a catchment permits flattening of flood peaks before flows reach the congested areas.
>
> (3) Flexibility of operation. A flood results from the combination of early rains up to the point of soil saturation followed by rains of high intensity. A number of small reservoirs can be regulated to stagger releases and avoid the concurrent meeting of tributary flood peaks at their confluences with the main stream. It is difficult to mathematically evaluate the relative effectiveness of multiple storages compared with a single structure. My own opinion is that one acre foot of suitably apportioned multiple storages will have an effective control value of four acre feet in a single large reservoir located downstream.
>
> (4) Erosion control. When by overgrazing, protracted

droughts or fires the normal clothing of a watershed is impaired, sheet erosion of top soil and debris flows occur in amounts several hundred times more than under natural conditions. Reservoirs in upper reaches of tributaries will trap these materials near their sources. There are instances where such materials have been removed from the reservoirs and put to beneficial uses.

(5) Groundwater recharge. There are many instances where streams debouch upon valley areas, creating large fertile delta areas underlain with large underground storage basins. Some irrigated areas depend either wholly or in major part upon such underground reservoirs for their irrigation needs. Nature in the process of forming those deltas dropped the coarser gravels in the upper catchment areas above the deltas. The natural replenishments of the underground reservoirs occurs in those areas. Many basins are being depleted at an alarming rate. If some of our best irrigated lands are to continue in production we can best recharge those basins by following the pattern that nature has set up. A program of small control reservoirs in the upper tributaries facilitates a recharge program. By retardation and regulation of flood flows the discharges can be lowered to the point permitting those flows to accommodate the percolation rates in the tributary streams. Frequently a flood control reservoir operated for the purposes of flood control and conservation will in a single season store and release 3½ to 4 times its normal storage capacity.

I commend you for your support of sound methods of soil conservation. From a flood control standpoint, debris control and water conservation standpoint it is sound, economic and sensible.

Sincerely,

COURTLANDT EATON

It is probably safe to say that Mr. Eaton has far more experience and knowledge in the field of flood control than any of the Army Engineers, one factor being the Army custom of making frequent shifts in duties, which are likely to include many types of construction having nothing to do with flood control, such as planning military roads and defenses and overseeing a vast complex of technical operations not involving floods. There is rapid turnover in the Army Engineer field. The tragic fiasco of the Missouri River "flood control" operation tells us something about the proficiency of the Army Engineers in this respect.

A careful study of Mr. Eaton's statement is recommended to the businessmen's organizations, politicians, lobbyists, journalists and other boosters of the big dams, also to the "do-not-claim" appeasers in some top echelons of the U. S. Department of Agriculture.

The failure of a considerable portion of the engineering profession to view the flood control problem in all its phases, with eclectic studies of siltation, soil physics, chemistry, biology, ecology, farm economy, land use, health factors, human rights, ground water recharge, and other vital factors is probably due to over-specialization. To those who lean toward the big-dam cult, an acre foot is just an acre foot of water, whether it is found in Boulder Canyon, Arrow Rock reservoir, the Maumee, or the Des Moines River. They seem to be oblivious to the vast web of vital forces that make the prairie plowlands as different from the rugged Rockies as a turtle differs from a mountain beaver.

CHAPTER FOURTEEN

Municipal Water Supplies

The city of Clinton, Oklahoma, with a population of nearly 12,000, faced a severe situation as to its water supply during drouth years. The supply is an artificial reservoir, fed mainly by three streams, one of which is Little Monument Creek.

In the 1930's the creek, like many others, was dry. Up to the drouth years of 1952-53 the lake had accumulated a considerable amount of silt, which aggravated the problem.

In the 28 months preceding April, 1954, the general watershed experienced a drouth worse than that of the 1930's.

Nevertheless, Little Monument Creek, with a watershed of ten square miles, contained a flow of clear, ground-filtered water that approximately offset the daily average consumption. Evaporation subtracted somewhat from the supply after it reached the lake, but the flow was there, and it came from a source that defies

evaporation—ground storage, with higher water table, revived springs and blessed relief for the thirsty.

The vivid contrast with the situation on the same creek in the 1930's was caused by just one thing—a fairly complete and recent program of soil conservation treatment on that ten-mile square watershed. This produced insoak which was stored away in the normally moist years prior to 1952, so that in 1954 the Clinton people were drinking and using water that had fallen on Little Monument Creek watershed three, four and perhaps five years before, while rainfall was reasonably abundant.

This situation caused such a sensation in Oklahoma that a motion picture was made of the running water and other features. Not the least important phase of the picture was the showing of the agricultural prosperity on the Little Monument Creek watershed, shown in equally vivid contrast with the crop failures and obvious depreciation of adjoining watersheds where soil conservation treatment was yet lacking. The insoak program was a co-operative adventure in which everybody was the winner.

Municipalities, being human, are unpredictable.

As this book is written it is not known what the city of Enid, Oklahoma, is going to do about its two most vexing but still incongruous problems—floods, and what to do about an improved water supply. However, its citizens have held meetings which could result in a most valuable and illustrious example. So it is taken as Exhibit A in a hopefully imaginary consummation. Enid has taken steps in the right direction, and if the

path is followed to its logical conclusion, there will be a most significant story from this thriving city of about 40,000 population—the center of a rich wheat and cattle area.

It lies near the mouth of Boggy Creek, which is dry most of the time, but occasionally becomes a cantankerous torrent, flooding a considerable part of the city.

This watershed of about 13½ square miles is underlaid with fairly porous ground, with a "floor" of impervious shale about 40 or 50 feet below the surface.

The city is growing beyond the capacity of its present water supply, and it is estimated (allowing for various types of surface absorption) that if all the water falling on that watershed were captured, it would yield about 5,000,000 additional gallons of ground storage water per day, averaging the annual rainfall.

It is inevitable that in any healthy, up-and-coming American city there should be arguments.

So, of course, the old argument comes up: Shall we hurry the excess water downstream, into Skeleton Creek and the Cimarron River, or shall we try to keep every drop of it?

As the writer was finishing this book, Henry B. Bass, an outstanding Enid citizen, wrote a circular letter to his friends and neighbors. It is such an excellent presentation that portions of it are reproduced here. He said:

"I was born on the banks of a branch of Boggy Creek which long since has disappeared into the Elm Street storm sewer. For 56 years the creek and its watershed have played important parts in my life. As a boy I fished

in pools along its course. In what we called forty foot hole, located where is now the intersection of South Van Buren and Lahoma Road, I learned to swim.

"Time after time I have watched turbulent waters from its drainage shed swirl through Enid leaving wreckage and despair in their wake. The most recent flood of July 29, 1950, did $2,000,000 damage in the city. I have never heard an estimate of the harm rendered Garfield County roads, bridges, and farms but in County Commissioner Earl Evans' district alone, it was necessary to replace 103 washed out bridges.

"The watershed appears to be so flat soil erosion would not seem to be much of a menace in this particular area. Yet, upon the recession of its high water marks, inches of mud are left wherever they reached. This silt could come only from one place. It represents the wasting of the finest of the soil with which we have been so bountifully blessed. Of late years as gullies and even ravines too deep and wide to be plowed appear with increasing frequency, our mirage of freedom from the woes of erosion disappears into the myth of an iridescent dream.

"Even while part of our land is depleted by washing, another considerable amount is rendered useless because it is so flat. Water stands upon it drowning crops and souring the soil. No small area is covered by potholes which are difficult and even impossible to drain. Water remains in these depressions until evaporated or until it soaks into the sands below.

"Sixty years of using the shallow moldboard plow in our wheatfields has created an artificial hardpan just

below the surface. This further lessens the insoak properties of the soil and causes a faster runoff of water, thus more rapidly washing away top soil and increasing the volume of flood water.

"Through all its history the city of Enid has obtained its water supply from water sands beneath Boggy Creek's watershed. The withdrawal of this tremendous gallonage, along with discouragement of surface water insoak by modern farming methods, have lowered our water level to a point where the city is compelled to seek elsewhere for a supply. And many farmers are discovering to their sorrow that water wells can approach a point of exhaustion.

"Dayton, Ohio, for a century suffered continual floods from waters of the Miami River. In 1913 a particularly bad overflow caused the loss of hundreds of lives and inflicted damage running into many millions of dollars. An aroused citizenry determined to do something about it. Despite legal obstacles, selfishness of individuals, and lackadaisical interest by many, a plan was finally evolved which has effectually prevented further disaster.

"Dr. A. E. Morgan, later of TVA fame devised the system which apparently is the first flood retention dam project ever built. It seems he got the idea from an ancient dam built by the French in the 14th century.

"Each time I drove over this marvel of engineering ingenuity I reflected upon my hometown's predicament and wished a miniature Miami River Conservancy District could be created to control Boggy Creek. But I

would think of the flatness of Garfield County's terrain and sadly conclude there were no suitable sites for flood water storage basins such as border the Miami River Valley.

"I believe some of our worst troubles can be cured by better handling of our soil and rainwater. Deep plowing and chiseling can break up the artificial hardpan which has developed thereby permitting much of the water that falls to permeate deeper into the subsoil. By means of terracing and contour plowing most water can be kept where it falls, thus effectually stopping the carrying away of our precious top soil.

"Most of the water which cannot be held on the land by these methods can be detained for a few hours by a series of flood water retention dams. In the vicinity of Enid open and concealed storm sewer lines should be built to care for any water which might escape these guards on the rare occasions when a ten inch rain occurs.

"I am convinced by diligent effort these methods can accomplish the following very desirable results:

1. Erosion of soil halted.
2. Land already eroded restored to cultivation.
3. Flat areas properly drained.
4. Subsoil moisture maintained.
5. Floods stopped.
6. Water level in underlying sands restored."

Whether Mr. Bass's advice is heeded still remains to be seen, but to the writer of this book, Enid and Clinton,

from now on, stand as possible and potential exponents of a program that may be profitably followed by thousands of American communities.

In a general way, most American communities are overlooking the great value of underground storage. Recharge of ground water has been standard practice in some parts of Long Island since 1935, but this practice is a long time taking hold.

Many of the larger cities have to go a considerable distance to get surface-stored water, through pipelines. Admittedly even the most ideal ground water supply couldn't take care of a large, congested metropolis. However, there are some good-sized cities that get all or most of their water from the ground. Des Moines is one example, having the advantage of a glacial deposit of gravel along the Raccoon River bottoms. Houston gets a considerable part of its water from wells.

The smaller cities—say from 100,000 population down—would do well to investigate the ground water situation in their own front yards or at a convenient distance for piping.

No rule can be laid down to suit all locations, for geology varies; chemical content varies, and so on.

There are all degrees of hardness. Certain chlorides furnish a troublesome problem. Something approaching the rainwater degree of softness is desired, and that causes some communities to favor surface runoff gathered in surface reservoirs. But this system has its disadvantages as well, for the water drains from deposits of erodible surface filth, and there is a tremendous evaporation factor.

As a general rule, however, it would be highly desirable for the smaller cities, towns and villages to give primary attention to water wells, and, above all, to insure the steady supply of water in those wells by promoting soil conservation practices on the catchment area and seeing to it that every gallon of water is saved.

Arthur Hawthorne Carhart brings out in his exceedingly fine book, *Water—or Your Life,* the fact that water consumption is constantly growing, especially for industrial uses, but also for household appliances and home use in general.

As mentioned before, the National Engineers' Council, in its brochure on national water problems issued in 1951, gives preference to ground storage. The best thing about this system is that ground storage necessitates insoak, and insoak is necessarily integrated with soil conservation.

It might be said, in some future saw, that "a drop in the ground is worth two on the top."

CHAPTER FIFTEEN

Small, Mighty Devices

Back in 1918, a young civil engineer in southern Nebraska, working in co-operation with agricultural agencies (before the U. S. Soil Conservation Service was organized) devised a mechanism called the drop inlet.

The engineer was J. Frank Relf. As this book is written he is living in retirement at Ponca City, Okla., after serving many years with SCS and related services.

The drop inlet, to which brief references have been made in previous chapters, consists of a vertical spillover outlet for water from a pond or other depression where water tends to gather. Instead of taking water from the lowest part of the depression, it projects upward to any desired elevation so that the excess water does not begin to flow out of the pond until the water level reaches the top of the drawdown tube. This accomplishes two important purposes: (1) It leaves some

capacity for impounding water in the pond that otherwise would escape down slope. A multitude of such structures would therefore tend to hold water high on a watershed and relieve channels of streams down the slope. (2) Muddy water coming out of raw plowed fields is quieted down; silt is precipitated to the bottom and only the clearer water finally escapes when the water level reaches the top of the drawdown tube.

When such a device is placed at the upper part of a gully where formerly an ordinary culvert was used to convey runoff, the end result is to stop gully erosion and build up silt until it reaches the level of the draw-down tube. Grass and other vegetation soon take over. Mr. Relf has photographs showing remarkable results in healing great gashes in the terrain caused by gullying, until the healed-over portion merges into the adjacent landscape. In some cases huge gullies, up to 35 feet deep and 50 or 60 feet wide, have been completely healed. Before-and-after pictures show the transformation.

Hundreds of the drop inlets have been employed by road builders in various parts of the prairie states. They are used in constructing the small detention reservoirs of the SCS. The Turner Turnpike of Oklahoma, completed between Oklahoma City and Tulsa in 1953, is equipped with drop inlets in every indicated place. By the time the silt finally reaches the level of the top of the tube, the vegetative and brush covering is so well established that erosion in that sector is eliminated and the terrain is permanently stabilized.

In the case of the small detention dams, the drop inlets perform the indispensable function of emptying all

water above the permanent pool level, at a safe rate, thereby preparing the upper level—the flood pool—for the next deluge.

Another important device of the smaller category is the farm pond, useful for holding water high on the watersheds and also for stock-watering, recreation, and irrigation.

On January 1, 1953, there were 41,156 farm ponds in Oklahoma, and a projection of past history indicated a total of 45,872 as of July 1, 1953. There are 6,000 in Osage County alone.

No statistics as to capacity are available, but an SCS man who is familiar with the work estimates an average of four or five acre feet capacity per pond. It is therefore probable that the retention value of all farm ponds in the state as of 1953 would range from 10,000 acre feet up to 200,000 acre feet, depending on whether there had been drouth or wet weather. At any rate this retention value is seen to be a worth-while factor, in the overall pattern of stopping water where it falls. Oklahoma probably could use ten times as many farm pond reservoirs as it now has, and the more the better.

The gully plugs of the SCS agricultural flood control projects numbered 144 on July 1, 1953. These are considerably larger than the average farm pond, but smaller than the detention reservoirs. Many of them have a modified form of drop inlet.

As mentioned in Chapter 12, the farm pond has proved to be a highly effective flood-stopping device on the farm of Jess Dewees, pioneer conservationist of

western Oklahoma. The efficacy varies with different types of terrain.

The farm terrace is one of the next smaller features of flood control though, in total capacity, it has an enormous effect since single counties sometimes have thousands of miles of terraces. Usually the terrace is sloped, along the contour on the face of the slope, an inch or two for each 100 feet, depending upon the absorptive quality of the soil. Tight soils require slightly greater slope than loose, porous soils, because the latter will absorb water faster and take the load off the channel half of the terrace. It is an unforgivable sin to calculate the slope in such a way that a terrace channel fills up and spills over to the next terrace below. Such an error will soon destroy the terrace system. It is even worse to plow, disk or harrow up and down the slope, over the terraces, as that is likely to start rivulets that will likewise destroy the ridges.

When a tight soil is encountered, and a slight lateral contour-based slope is employed, the channels must have outlets, which have to be sodded, and these have to empty into sodded waterways for disposal of excess water, which, in a well-designed system, will lead into farm ponds and detention reservoirs as hitherto described.

Contour listing or furrowing is the next smaller pattern, the ridges and channels forming miniature terraces. Basin listing, composed of a series of small depressions in the ground, is another valuable device. Deep chisel plowing greatly accentuates the insoak.

Finally, of course, comes the individual blade or root

of grass or other vegetative covering, which, in the aggregate, furnishes innumerable billions, trillions, and quadrillions of tiny dams to stop water where it falls, or at least "slow it down to a walk."

It is these small, wonderful devices of nature which, together, make the only dam system worth having.

PART IV

CONCLUSION: A LAND WITHOUT FLOODS

CHAPTER SIXTEEN

We Can Take Our Choice

Suppose we, the people, accept the Pick-Sloan Plan of flood control, what will we get from the operations of the Army Engineers and Reclamation Bureau people?

According to their own prospectus, exploited in 1948, the total program, past, present and future, mounts to $57 *billions*. (We have learned, through former President Hoover, the Kerr subcommittee, and others, that we would have to add at least 100 percent to that figure, but let us say $57 *billions* to be generous.)

This sum is too large to be comprehended by the average taxpayer, so we might break it up into smaller parts—say $100 millions or $200 millions at a clip.

The writer has a map of Oklahoma, issued by the Oklahoma Planning and Resources Board, in co-operation with the Army Engineers and Reclamation Bureau, showing 68 different dam projects, which plentifully sprinkle the state, in some cases taking 100,000 acres at

one gulp. Remember this is all bottomland—the choicest and most fertile.

Col. Francis Wilson, when head of the Army Engineers in Oklahoma, made an official statement declaring that it was necessary, for complete flood protection along the Grand River, to construct three huge reservoirs which would take up practically all of the Grand River Valley. (In Kansas, the remainder is called the Neosho.) To grasp this, get out your map and see what this means. Three large, long artificial lakes are scheduled, and the two largest have already been built.

Contemporary statements by Gen. Pick and other high Army Engineers plainly point to a similar system all over the Mississippi Valley.

There is where you begin to understand the meaning of $57 *billions.*

The Oklahoma program alone, on the map just mentioned, according to advance estimates, amounts to $241,940,000, but every figure has been greatly exceeded, as is the custom.

The ideal Pick-Sloan program would consist of a network series of huge reservoirs, covering the valleys of every river in the nation.

This much has been virtually admitted by the big-dam promoters themselves. So up to this point there would be little if any quarrel with the specifications.

As stated before, high Army engineers also have publically admitted the magnitude of siltation.

So even up to this point there wouldn't be much attempt at rebuttal by big-dammers. The short life of the reservoirs placed in the midst of major muddy rivers,

also is universally conceded by eminent geologists, who know more about the subject than anyone else.

So what *will* we have if and when this super-colossal series is completed?

We will have a stupendous series of bowls receiving land-soup—the rich lifeblood washed out of topsoil. Here in these vast casseroles of carcinomatous organisms —formerly healthy tissues now in the wrong place—the organic and soluble substances will wash out over the dam, leaving dead rock-dust, sand, and gravel to fill up the grandiose bowls. The rich plasma of the vital earth will be gone forever, leaving dead mockeries.

Above these multitudinous and rapidly silting bowls will be indefinitely long flood-plain zones of backwater sedimentation to insure the ruin of all the rich bottom-lands not inundated by the huge lakes. If anyone had deliberately planned to wreck all the fertile valleys of America, he could not have devised a more devilishly effective program than that.

At this writing, Oklahoma, which has been given more big federal dams than the average farm state, shows this record: More than 650,000 acres inundated or to be inundated if all the authorized dams are built. The estimated cost will be not less than $700,000,000, but in view of the fact that estimates are usually far below the eventual cost, the final figure will be something like $1,500,000,000.

And to what end?

On the other hand, if the agricultural flood control program prevails, we will have:

1. Continued and greatly increased farm prosperity, which is the economic underpinning that is absolutely essential to the survival of the nation.

Money now being spent for the multi-billion dam program (and perhaps the PMA pork-barrel, if our largest and best farm organizations are heeded) can be made available for soil conservation methods in which the stopping of water where it falls is a *sine qua non* of soil-saving. (You simply *can't* save soil without stopping water where it falls, so flood prevention has to be synonymous with soil conservation. It is just that simple, and no amount of quibbling can change this formula. If any so-called soil conservationist says that "downstream flood control is also necessary," he is not only putting his blessing on the inundation and demolition of millions of acres of our best soil, but he is simultaneously admitting that his own job of soil conservation is being bungled. Efficiency in flood control necessarily comes in the same ratio as efficiency in erosion control.)

2. A high water table, with enormously increased underground water storage, which the highest engineering authorities agree is preferable to surface storage.

3. Revived springs, yielding clear water, purified through nature's own filter beds.

4. Clear streams, running deep and narrow, all through the year, to replace the fitful muddy-and-dry rivers of today. We know this objective can be achieved because it was the norm of the primitively natural river system.

5. Vastly improved recreation, especially as to fishing, swimming, hunting, picnicking, and camping. The

most eminent biologists recognize the superior ecology of clear streams and small silt-free lakes, involving a larger ratio of feeding grounds to total volume of water than can be achieved in big reservoirs, especially those that are silting up.

6. Irrigation by clear water, which is also essential to a permanent agriculture in moisture-deficient areas. Such irrigation water can be pumped from an abundant ground storage, or it can be drawn from small siltation-protected detention reservoirs.

7. Complete flood prevention, brought by a multitude of small detention reservoirs, constructed at much lower cost than the big ones in comparable areas, able to impound far more runoff water than big dams. These are augmented by surface treatment.

8. A system that much more than pays for itself as it goes, by saving the soil, in vivid contrast with a system that is enormously expensive and produces great economic loss instead of gain.

9. Health for the people. The retention of highly valuable organic and inorganic substances in the topsoil has been lately revealed as a prime preservative of good health.

10. A system that keeps people on the land instead of driving them off the land.

CHAPTER SEVENTEEN

A Dream for the Future

If enough Americans recognize the foolishness of Big Dams and the soundness of agricultural flood control, what can we hope for by the year 2003?

We can best judge the future by the past, so we might first visualize the kind of a world young Jess Dewees saw in 1894.

Oklahoma, then, was a land of teeming life, colored by a rippling sheen of grass. Sometimes the mass of bluestem would hide a horse. Washington Irving, in his *Tour of the Prairies,* caught glimpses, ranging from Fort Gibson westerly and southwesterly in a sweeping circle. He tantalizingly described this paradise for hunters, fishermen, and what few farmers there were there in the 1830's, about 60 years before the Dewees boy gazed in wide-eyed wonder at the profligate gifts of nature, in a land only recently deserted by buffalo, antelope, and deer.

There was virtually no erosion in Dewees's boyhood, for nature's balance had obviated that. Floods were infrequent, and if they should come—perhaps once in 25 or 100 years—they would slide harmlessly over the long grass. For the most part the sod-sponge and forest-sponge soaked up the precipitation.

Jess Dewees saw a land of lush and verdant vegetation. All the streams ran clear, deep, narrow, and steady. Fish were plentiful, for there was a steady flow of water all year, since the water-travel was equalized by the retarding action of the porous underground avenues containing broad, deep veins of clean water, automatically filtered. The water table was high, as learned by those who dug wells. Wildlife had abundant cover and feed. The banks of streams were lined with heavy carpetings of green grass and with clothing of trees, shrubs, and vines. Except for infrequent rock outcrop there was no exposed terrain.

For the year 2003 we may dream of a return to something like this blessed condition, or even a better one, for enlightened civilization has caught onto the significant trick of the *contour,* which tends to frustrate the gravity-pulled water and makes it take a much longer and more circuitous path as it is drawn toward the sea level. Terraces, furrows, and deep chisel-grooves through tough subsoil implement this neat trick, to augment nature's own insoak. Ingenuity also has devised small containers for appropriate locations, high on the long slopes—for the higher the water is stored, the greater the potential. We may visualize these gadgets as double-insurance or safety valves, for by the year 2003 it should

have been found possible to stop any deluge in its tracks, by sponge absorption alone.

Open-tilled land might still be a considerable factor, even though studies by Faulkner, Cocannouer, and the organic farmers indicate a greater reliance on natural cover, stubble-mulch, and even unbroken ground, depending upon local circumstances.

If the land were open-tilled, however, precautions would be taken to prevent runoff by contour cultivation, strip cropping, rotations and the like.

Sometimes, alternate rows of grains and legumes would be used on the contour, according to research by Dr. Horace Harper and others.

As of the year 2003 there would be very few large reservoirs in the midst of river systems in the prairie plowland areas, for several good reasons:

(1) It would have been found that they would be superfluous so far as flood control was concerned, and the small detention reservoirs, protected from siltation by conservation treatment on their watersheds, would afford ample recreational and storage facilities; (2) It would have been firmly established by geological and hydraulic surveys that ground storage potential is many times greater than any conceivable surface reservoir storage, having a total capacity of eight times the annual national rainfall; (3) surface reservoirs built in the 1940-50 era would be filled up with silt and those built in the 1950-60 era would be in bad shape for the same reason and not good for much except duck marshes.

A few surviving large reservoirs would be found—these being reservoirs built after the complete SCS treat-

ment was applied. These would promise to have a fairly long life because the entire watersheds would be stabilized and protected from erosion. They would be fed by clear water from streams that had been cleared by conservation practices. However it would be realized that even such protection would not be conclusive, as shown by extensive siltation of many mountain streams.

There would be a maximum of revegetation and a minimum of plowing. Instead of moldboard plows there would be greater reliance on deep running chisels and disk plows, always with the greatest possible retention of surface trash.

Sweet clover and other domesticated legumes with deep, tough roots would be used wherever there was a tough plowpan, thus opening up myriads of channels for insoak. Some plants hitherto called weeds would be found to be equally useful, not only for penetrating the plowpan but for improving soil texture, and for making ensilage.

Among the most attractive features of the farm region landscapes of the year 2003 would be the little detention reservoirs, now looking like natural lakes, being bordered with luxuriant growths of trees and other verdure. These would be frequent gems in the countryside —sparkling clean water set in the midst of forest and meadow belts, teeming with fish and wildlife, fed by clear creeks and springs, the product of adequate insoak practices on the watersheds.

The general landscape, because of intensive local treatment, would resemble that of the best sections of European nations, where the gradual drizzling rains

had previously produced an advantage. Now, as of 2003, Americans would have learned how to overcome the handicap, by adapting techniques to the climate.

Visualize a national gathering of people interested in land use—not only farmers, but people from every walk of life. By this time the people would have realized that we all "belong to the land," and what concerns the farmer also vitally concerns the urbanite.

This gathering might be the "Third Annual Congress on Water Management." Not "flood control," as in 1953, for by this time the flood would have become obsolete, a relic of a past age, since ways and means would have been devised whereby water would be considered a total blessing, even in huge downpours, for superabundance could be stored against the thirsty time.

The delegates to this conference of 2003 and the speakers would include laymen of all occupations, and the list of authoritative speakers would not be confined to mechanical or civil engineers, but would include scientists who had specialized in biology, bio-chemistry, animal husbandry, medicine, chemistry, agronomy, farm economics, geology, soil physics, forestry, underground storage, sedimentation studies, the applied science of "hydro-geo-biology," to study the most critical phase of the hydrologic cycle—these being typical of the wide range.

Other transactions and proceedings of the conference would relate to painstaking studies of the behavior of water after it reaches the ground, how it becomes incorporated with a vast array of substances, to synthesize

the life stream, how it can be managed or guided in its multifarious activities as the force of gravity or of capillary attraction or the pump-action of plants or evaporation have their effects. Special attention would be given to research in antibiotics.

The quaint notion that water management consists of nothing but "control" of vast volumes of unruly muddy water would be left far behind, for management would have come to be envisaged as the concern of many departments of science, since water is a priceless and magic liquid which ramifies necessarily through small detail into an amazingly large and diverse network of natural and partially human-influenced operations.

The great increase in population would mean that intensive farming, such as is practiced in the densely populated areas of the Old World, would have been adopted in the United States, and of course erosion would have virtually ceased.

The countryside, from Maine to California and from Key West to Seattle, would be classified as to best land use, not by federal bureaucracy but by district conservation workers, collaborating with scientists from the various technical institutions, on an autonomous basis.

Land use would be a thorough-going, broadly applied science, based upon surveys and analyses of soil types and climate, nearness to markets, the general farm economy and other factors, including urban life and economy. Rural zoning would have been accepted as a cooperative program to insure an overall balance between rural and urban life and the best possible uses of land,

with special attention to watercourses and storages. Decentralization, to a large extent, would prevail. The city and country would mingle.

Highways would be completely surveyed and treated so that they were not "secondary water courses" (a term aptly applied by Dean Glenn Couch of the University of Oklahoma in stressing the need for conservation treatment of public roads). They would be featured by heavy, regulated vegetative growths, drop inlets, dikes, diversion ditches, and other devices for preventing runoff water from damaging the right of way or adjacent properties.

All land not subject to cultivation would be cleanly allotted to grass production, forage, forest, recreational areas, wildlife refuges, etc. There would be no surface runoff because of preventive measures which would confine the flow of water to stabilized water courses fed by springs. Little by little the topsoil, relieved of the constant whipping, leaching, and scourging of surface runoff and wind, would accumulate organic material left over after the crops were taken off.

There would be no stream pollution in the year 2003. All sewage and garbage waste would be impounded, processed, and made into food-producing fertilizers and other factors to condition the soil. Earthworms would play a highly important part in the soil conditioning, likewise a wide variety of hormones, enzymes, antibiotics, trace elements, and other substances. Instead of farmland being depleted, it would receive accretions by way of intelligent additions, natural and artificial.

Forests would be replenished, with adequate autono-

mous regulation of lumbering operations, with special attention to plantings that retard runoff, insuring, meantime, that the federal government did not expropriate forest land for projects that would work hardship on the people of the region. The over-grazed areas of the semi-arid regions would have been retired as wildlife refuges and recreational areas, to halt the terrific and destructive erosion as of the year 1953. The raising of the water table in mountain valleys would produce innumerable trout streams where, in 1953, there were dry "washes" alternating with the muddy flash floods of rainy spells.

Reserves like the Philmont Scout Ranch of 127,000 acres in northern New Mexico would serve as models for similarly located tracts elsewhere. They would all be laboratories of conservation.

The vision of great sportsmen's organizations like the Izaak Walton League and the Wildlife Federation would be realized in a tremendous increase in wildlife living in harmony with intensively farmed fields and teeming cities.

The balance of nature would be restored, in 2003, after nearly two centuries of frenzied exploitation and unbalanced butchery. That is the dream we can realize.

* * * * *

Patriotism means nothing at all if people say of some destructive trend, "Let the next generation worry about that."

We need to love the United States of the year 2454 as passionately as we love the United States of today and

yesterday, otherwise there is only a shallow, fickle, and meaningless love. We need to have at least as much foresight as the Greeks who built the Parthenon or the Egyptians who constructed the pyramids.

What is the meaning of United Nations or American world leadership, or the fight against communism or totalitarianism, if we are thinking, like the ephemera, only of today?

The deepest and most holy instincts of humanity have to do with posterity. Without such solicitude, parenthood and parental love is meaningless and all human life becomes an empty fraud.

The writer is an optimist, with faith in the ponderous but sure veering of American public opinion toward the course of action that will preserve our heritage.

He believes in the sturdy and instinctive vision and determination of people like those of the Blue Valley of Kansas and the Washita watershed of Oklahoma, who will fight until the nation sees the rightness of their battle—fight for their homes and their altars and their liberties and the land they love.

We can have the kind of environment pictured in the dream of 2003 if the people will awaken to the need and study the best means of achieving the end. There is nothing theoretical or visionary about it, for such environment already has been produced where man has co-operated with nature instead of indulging in clumsy efforts to "conquer the wilderness."

The wilderness is never defeated. In many spots on earth it has been given a temporary setback by over-intensive and crowding urbanism, excessive exploitation

of natural resources, and bumbling efforts to set up new rules that do not integrate with the natural order. The wilderness is naturally beneficent and kind, but when it is too hard pressed it turns and strikes savagely and always effectively, for Mother Nature is the one woman who always has the last word.

The effort to conquer the wilderness instead of working with it, operates paradoxically but automatically toward ultimate restoration after man has learned his bitter lesson and has disappeared—first by utter desolation, then, when man and his animal companions have been starved, by the return of the jungle or the hardy weeds of the desert. In the case of the Sahara and perhaps a few other areas which were once productive and then over-exploited and devastated, the return to fruitfulness may be postponed for thousands of years. Perhaps a new glacial age or other vast readjustment would be required. In any event the wilderness—whether desert or jungle—always wins in the end, either by way of preliminary and intermediate desolation or by way of a new and contrite spirit of co-operation between man and nature. Always remember that man is the only creature that destroys its own environment.

Schools, colleges, and the general public will do well to study the normal operations of the ideal wilderness. Certainly such operations do not include the setting up of vast concrete and steel barriers across the paths of major silt-bearing streams, for we have the grim, inexorable dictum: "The history of a lake is the history of its death." Such barriers are an obvious and bumptious abnormality. There is nothing in such structures which

can postpone the dreadful deterioration of our environment which has been so well pictured by Sears, Vogt, Osborn, and others. They are foreign to the great scheme of a beneficent wilderness, in which every detail argues for the little waters, the tranquil movement of very little waters to keep life going, in the orderly operations of the hydrologic cycle, through the wisdom of those who live close to the soil.

Glossary

(Compiled with valuable aid from the *American Journal of Soil and Water Conservation*)

Acre-foot—The quantity of water, soil or other material that will cover one acre to a depth of one foot.

Aggradation—The building up of any portion of the earth's surface toward a uniformity of grade or slope by the addition of material; especially the deposition of sediment in the beds of streams, and on the floors of bodies of standing water.

Agronomy—The application of scientific principles to the cultivation of land.

Alluvial Fan—A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where its gradient lessens abruptly.

Aquifer—A porous soil or geological formation which yields water to wells and springs.

Arid—A term applied to climates which lack sufficient moisture for crop production without irrigation.

Backwater Sedimentation—Deposit of water-borne sediment in stream channels or on the flood plain above a dam or other obstruction, caused by the slowing up of current velocity.

Bacteria—A large group of unicellular microscopic organisms widely distributed in air, water, soil, and bodies of living animals and plants, and dead organic matter.

Badlands—Areas of rough, irregular, denuded land on which most of the surface is occupied by ridges, gullies, and deep channels.

Biologic Desert—A term believed to have been coined by J. N. Darling to indicate any environment that is incapable of supporting life.

Bottomland—See Flood Plain.

Bunch Grass—A grass which has a characteristic habit of growing in tufts or bunches.

Capillary Water—The portion of soil water which is held by cohesion as a continuous film around the particles and in capillary spaces.

Channel—The part of a natural stream where water normally flows, or a ditch excavated for the flow of water.

Channel Improvement—The improvement of the hydraulic flow characterictics of a natural or artificial channel by clearing, excavation or other means in order to increase carrying capacity.

Check Dam—A small, low dam constructed in a gully or other watercourse to decrease the velocity of stream flow, for minimizing channel scour and promoting the deposition of eroded material.

Chiseling—The use of deep-running narrow blades for the purpose of breaking up the subsoil, to permit and encourage infiltration of water and produce better tillage conditions.

Clay—Small mineral particles of the soil, less than 0.002 mm. in diameter.

Claypan—A horizon of accumulation or a stratum of dense compact and relatively impervious clay.

Clean Tillage—Cultivation to prevent the growth of all vegetation except the particular crop desired.

Compost—A pile of decomposing organic matter of plant or animal origin. Soil and other amendments such as lime, nitrogen, and phosphorus may be mixed with organic matter.

Contour—An imaginary line on the surface of the earth connecting points of the same elevation. A line drawn on a map to show the location of points of the same elevation. A series of contour lines on a map shows the topography of the land.

Contour Farming—Conducting field operations, such as plowing, planting, cultivating and harvesting, on the contour lines.

Contour Furrows—Furrows plowed on the contour on pasture or range land to prevent soil loss and allow water penetration.

Contour Strip Cropping—The production of crops in comparatively narrow strips planted on the contour and at right angles to the natural direction of the slope.

Cover, Ground—Any vegetation producing a protecting mat on or just above the soil surface.

Cover, Vegetation—All plants, of all sizes and species, found in area irrespective of whether they have forage or other value.

Cover Crop—A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of regular crop production, or between trees and vines in orchards and vineyards.

Cropland—Land regularly used for the production of crops (except forest crops and permanent pasture).

Crop Residue—The portion of a plant or crop left in the field after harvest.

Crop Rotation—The growing of different crops in recurring succession on the same land.

Cubic Foot per Second—See Second-foot.

Dam—A barrier to confine water for storage or diversion.

Delta—An alluvial deposit formed where a stream or river drops its sediment load on entering a body of more quiet water, formed largely beneath the water surface, and often resembling the shape of the Greek letter Delta.

Deposition—The accumulation of soil material dropped because of the slackening movement of the transporting agent —water or wind.

Desert—An area with an extremely arid climate. Also applied to any area from which fertility is exhausted.

Detention Dam—A dam constructed for the purpose of temporary storage of stream-flow, or surface runoff, and for releasing the stored water at controlled rates.

Dike—An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands. A levee.

Diversion—A channel with supporting ridge on the lower side constructed across the slope to intercept runoff and minimize erosion.

Drainage—The removal of excess surface or ground water.

Draw—A natural depression or swale; a small natural drainageway.

Drop-inlet Dam—A dam with provision for carrying off overflow through a gently sloping pipe under the dam, connected to an open-top vertical pipe, or riser, at the pond side of the dam.

Duckfoot—An implement with horizontally spreading V-shaped tillage blades, or sweeps, which are normally ad-

justed to provide shallow cultivation without turning over the surface soil or burying surface crop residues.

Earth Dam—A barrier composed of earth (clay, silt, sand or sand and gravel) or a combination of earth and rock, used in confining water.

Eclectic—Made by selecting from different systems or sources. A combination of what is considered best from different systems or techniques.

Ecology—The science of biology that treats of the relationship between organisms and their environment.

Environment—The sum total of all the external conditions which may act upon an organism or community, to influence its development, or existence.

Enzyme—An unorganized or chemical compound of vegetable or animal origin that causes chemical transformation.

Erodible—Susceptible to erosion.

Erosion—The detachment and movement of the solid material of the land surface by wind, moving water, or ice. (Note: In this book the word's significance is amplified by applying it to the dislocation of larger objects.)

Essential Element—A chemical element which is required for the normal growth of green plants.

Evaporation—The process of vaporization by which a liquid or solid is changed to a vapor or gas.

Farm Pond—A small body of water retained behind a dam or held in a hole dug in the ground; of lesser area than a lake.

Feed—Harvested forage such as hay or fodder or grain, grain products and other foodstuffs processed for feeding livestock.

Fertility, Soil—The presence in the soil of the necessary ele-

ments, in sufficient amounts, in the proper balance, and available for the growth of specified plants, when other facts, such as light, temperature, and the physical condition of the soil are favorable.

Fertilizer—Any material which is added to the soil to supply one or more of the plant nutrients.

Fine-textured Soil—A soil predominantly silt and clay.

First Bottom—The normal flood plain of a stream.

Flood—Any excessive flow of water, anywhere.

Flood Plain—Nearly level land occupying the bottom of the valley of a present stream and subject to flooding, unless protected artificially.

Flood Pool—That portion of water reservoir that is intended to impound excess runoff from its watershed, the object being flood control.

Fodder—The dried, cured plants of tall, coarse grain crops, such as corn and sorghum.

Forage—Unharvested plant material available for use as food by livestock. May be grazed or cut for hay.

Gradient—Change of elevation, velocity, pressure or other characteristic per unit length. Slope.

Grassed Waterway—A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from upland.

Ground Water—Water standing in or passing through the soil and the underlying strata.

Gully—A channel or miniature valley cut by running water, through which water commonly flows only during and immediately after heavy precipitation.

Hardpan—A cemented or hardened soil horizon.

Hormone—A chemical product of an organ which produces activity in another organ by way of the blood stream.

Humid Area—A region where natural precipitation normally produces adequate vegetable growth without resort to artificial irrigation.

Humus—Organic matter that has reached a more or less stable advanced stage of decomposition.

Hydro-geo-biology—A term coined by the author (for want of a more exact word) to indicate the scientific study of the behavior of water in the soil, as affected by vegetation and other biologic factors.

Hydrologic Cycle—The circuit movement of water. Movement from the atmosphere to the earth and return to the atmosphere through various stages as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

Impervious—Incapable of being penetrated by water.

Impoundment—Collection or storage of water in any given reservoir.

Infiltration—The downward entry of water into soil or other material. Insoak.

Infiltrometer—A device for measuring the flow of water into the soil.

Inlet (Hydraulics)—1. A surface connection to closed drain. 2. A structure at the diversion end of a conduit. 3. The upstream end of any structure through which water may flow.

Insoak—Infiltration of water.

Land-capability Class—One of the eight classes of land in the land-capability classification, ranging from nearly level

and productive, not subject to erosion, to land not suitable for cultivation, grazing or forestry, may be used for wildlife, recreation, etc.

Land-soup—(A phrase coined by the author.) Impounded runoff water containing vital substances leached from the land.

Legume—A plant characteristically represented by peas, beans, peanuts, clovers, alfalfa, lespedezas, and kudzu.

Lister—A double plow, the shares of which throw the soil in opposite directions.

Litter (Forestry)—A surface layer of loose organic debris in forests.

Loam—Soil material containing 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Manure—Refuse from stables and barnyards containing animal excreta, with or without straw or other litter.

Mulch—A natural or artificially applied layer of plant residue or other material.

Multiple-purpose Dam—A dam designed to accomplish several objectives, for instance flood control, power generation, storage for irrigation or recreational purposes, etc.

Organic Farming—Soil culture that lays special emphasis upon the use of organic material as contrasted with chemical fertilizers.

Organic Soil—A soil composed mainly of organic matter on a volume basis.

PMA—Production and Marketing Administration.

Permanent Pool—That portion of a multiple-purpose reservoir which is intended to retain water for an indefinite period.

Plowpan—A compacted layer formed in the soil immediately

below plow depth. Formerly applied to condition caused by mechanical pressure of plow bottom, but now applied also to coagulated clay particles in a layer.

Power Pool—That portion of a water reservoir, immediately under the "flood pool," that is intended to furnish water for power generation.

Puddled Soil—A dense soil dominated by a single grain structure, almost impervious to air and water. This condition results from handling of soil when it is in a wet, plastic condition so that when dried it becomes hard and cloddy.

REA—Rural Electrification Administration.

Revetment—A structure or obstacles placed along the edge of a stream to stabilize the bank and protect it from the cutting action of the stream.

Ridge Terrace—A long, low ridge of earth with gently sloping sides, and a shallow channel along the upper side, to control erosion by diverting surface runoff across the slope instead of permitting it to flow uninterruptedly down the slope.

Row Crop—A crop planted in rows relatively far apart, usually 2 to 4 feet, to allow for cultivation between rows during the growing season.

Runoff (Hydraulic)—That portion of the precipitation upon a drainage area which is discharged from the area in stream channels.

SCS—Soil Conservation Service.

Sand—Mineral soil grains 2.00 to 0.05 mm. in diameter, USDA standards.

Scour—To abrade and wear away.

Second-foot—A unit of measurement of the volume of water flow; a cubic foot a second.

Seepage—Water escaping through or emerging from the ground along an extensive line or surface, as contrasted with a spring.

Sheet Erosion—The removal of a fairly uniform layer of soil or material from the land surface by the action of rainfall and runoff water.

Silt—Small mineral soil grains intermediate between clay and sand.

Sod—A surface layer of soil matted or held together by roots, rhizomes, and stolons of grasses, and other herbs.

Soil—Soil is a natural body developed from weathered minerals and decaying organic matter covering the earth in a thin layer.

Soil Conservation—The preservation of soil against deterioration and loss by using it within its capabilities and applying the conservation principles needed for its protection and improvement.

Soil Erosion—The detachment and movement of soil from the land surface by wind or running water.

Soil Horizon—A layer of soil approximately parallel to the land surface with observable characteristics that have been produced through the operation of soil-building processes.

Soil Profile—A vertical section of the soil from the surface through all the horizons into the parent material.

Spillway—A conduit in or around a dam for the escape of excess water.

Splash Erosion—A form of soil erosion resulting from soil splash caused by the impact of falling raindrops.

Spreader—A device for distributing water uniformly in or from a channel.

Storage—Collection of water in any given reservoir.

Storm—In general, a disturbance of the ordinary average conditions of the atmosphere.

Strip Cropping—Growing crops in a systematic arrangement of strips or bands to serve as vegetative barriers to wind and erosion.

Strip Sodding, Contour—The use of strips of sod on the contour, alternating with spaces which are not sodded.

Stubble—The basal portions of plants remaining after the top parts have been harvested.

Stubble Mulch—A protective cover provided by leaving plant residues of any previous crops as a mulch on the surface when preparing for and planting the following crop.

Subsoil—Roughly that part of the true soil system lying under the topsoil.

Summer Fallow—The tillage of uncropped land during the summer to control weeds and store moisture for the growth of a later crop.

Terrace—An embankment or ridge of earth constructed across a slope to control runoff and minimize soil erosion.

Tillage—Working the soil for the purpose of providing more favorable conditions for plant growth.

Topsoil—A distinguishable layer at the surface of the soil, often 6 or 7 inches thick.

Transpiration—The discharge of water as vapor into the atmosphere by the leaves and stems of living plants.

USDA—United States Department of Agriculture.

Underflow—Movement of water through a pervious or porous subsurface layer.

Vitamin—One of a group of organic substances occurring in minute quantities in foodstuffs essential to the maintenance of normal functions of animal life.

Wash—A term used in southwestern U. S. to denote a gully, usually an intermittent stream, as found in semi-arid regions.

Water Table—The upper surface of free ground water in a zone of saturation, except when separated from an underlying body of ground water by an unsaturated material.

Watershed—The total land area, regardless of size, above a given point on a waterway that contributes runoff water to the flow at that point.

Waterway—A natural course for the flow of water.

Weed—An unwanted competitive plant in fields, gardens, orchards, ranges and forests.

Wildlife—Undomesticated vertebrate animals considered collectively.

Windbreak—A barrier of trees and shrubs, usually in three or more rows, to reduce or check the force of the wind.